COLONY AND PROTECTORATE OF KENYA

DEPARTMENT OF AGRICULTURE
ANNUAL REPORT
1958

Volume II—Record of Investigations

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Volume III—Record of Investigations

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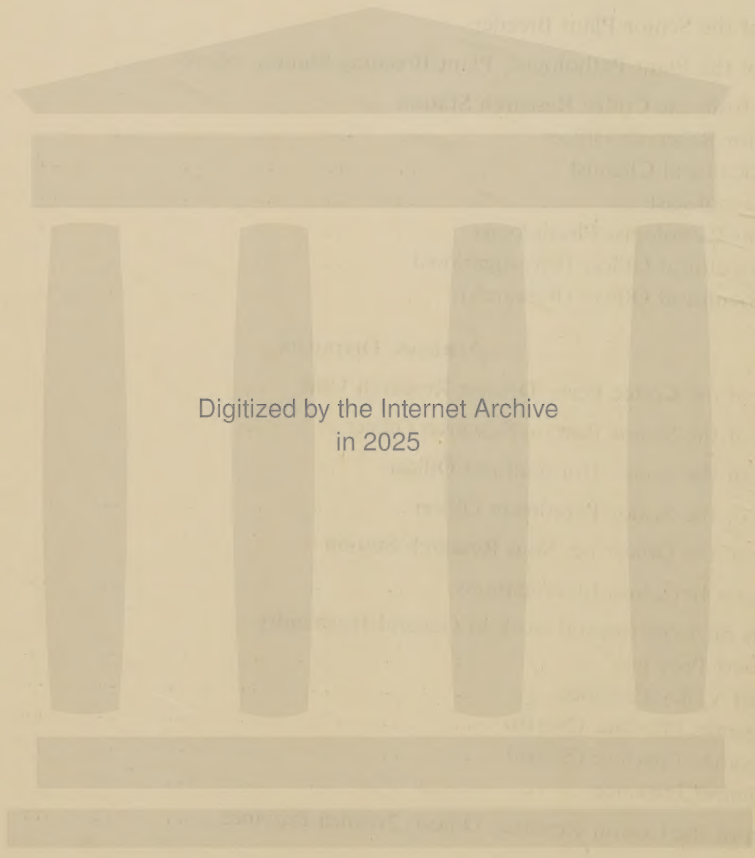

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INTRODUCTION BY THE CHIEF RESEARCH OFFICER

A general account of the work of the Department of Agriculture in 1958, including that of the Research Division has already been published as Volume I. In Volume II entitled "Record of Investigations" an account of the Department's research work is given in greater detail. This volume is intended for the reader who wishes to follow the work in progress more closely, and references to other published information and in most cases to stations where the work is being carried out are supplied. A serious reader can therefore follow up developments in any particular field which interests him by referring to other publications or making contact with the stations themselves.

Volume II has been published as a separate volume since 1949. Its publication in the present form has made it possible for Volume I to appear more quickly because, with some crops, experimental yield data are not available in final form until after the end of the calendar year and the compilation of the more detailed reports presented here does not therefore hold up publication of the Department's general annual report which must appear as soon as possible after the end of the year of reporting. In addition, the present system avoids the risk of confusing the general public by inclusion of too much detail in Volume I. It must also be recognized that the Colony's agricultural research effort has expanded rapidly since the war with a consequent increase in the annual accumulation of information of interest and value to the agricultural industry. This factor in itself has enhanced the need for separate publication.

By 1955, Volume II had grown in size to such an extent that it became necessary for reasons of economy to make a serious attempt to limit its size and a brief description of the manner in which this was achieved is necessary. Where research sections of the Department have special arrangements to publish full and detailed independent annual reports only a very brief account of their work is published in the present volume. Cases in point are the Annual Report of the Coffee Research Station, Ruiru, which is published by the Coffee Board of Kenya; the Annual Report of the Pyrethrum Research Station, Molo, which is published by the Pyrethrum Board of Kenya and the Annual Report of the High Level Sisal Research Station, Thika, which is published by the Kenya Sisal Board. Copies of these reports can be obtained from the organizations mentioned or the Officers-in-charge of the Research Stations themselves. In all branches every possible effort is made to see that completed work is published in the farming press and scientific journals and very brief mention of such work is all that is then necessary in this volume. Reference to such publications is given and interested readers can refer to the appropriate publications of which reprints are frequently available upon application to the Librarian at the Department's headquarters in Nairobi. In addition reporting officers are under orders not to include in the present volume long and detailed descriptions of work which is proceeding but which is not yet showing results of interest and importance. Such items receive only brief mention to indicate for the sake of completeness that work is being done on them.

By adopting these measures it has been possible to keep within the limited size allowed, and at the same time to present in reasonable detail information of value to farmers and other scientists which might otherwise have perforce received very inadequate cover. Volume II thus ensures an adequate general cover of all work in progress in the research field but its most important function is

to ensure that information which for one reason or another may never be published in any other form is in fact recorded in print. This is a matter of the utmost importance. The value of departmental annual reports as a source of information in later years has been conclusively demonstrated on many occasions; in fact they are sometimes the only source of such information. It is thus the intention to continue the publication of Volume II in the confident knowledge that the material presented will be of undoubted value to farmers, scientific workers elsewhere and to our own officers.

Farmer members of research committees have on occasion made the comment that current items of investigation have to their knowledge been fully examined at some previous date and express concern that investigations have to be repeated. Frequently there are good reasons why the work must be repeated, such as, for example, the present existence of more accurate evaluation techniques, but it is also true to say that the system of recording work in some cases in the past left a lot to be desired and records have been lost.

In such cases back numbers of the Department's Annual Reports may contain the only reference to work done. There were, of course, exceptions and well preserved archives exist on some stations. In general there has been a great improvement in the systematic recording of results of experimental work on stations and a comprehensive system of recording was introduced centrally in 1951.

Steps are now being taken to improve these arrangements still further by the introduction of a modern recording system which will cover all stations. When this system is in full operation it may prove possible to make further changes in the form of this volume. In the meantime it is considered that the publication of Volume II meets an essential need.

In introducing the present report space will not allow more than the briefest comment on the highlights of the year under review:—

(1) An important development was the appointment of a Stored Products Entomologist to investigate storage losses in wheat and to study the effect of insect infestations of produce entering and leaving the Port of Mombasa. Research includes studies on the biology and control of stored products pests under coastal conditions as well as research on the establishment of produce inspection techniques which are of very great importance, especially in relation to efforts being made, in co-operation with other East African territories, to exclude the notorious stored products pest *Trogoderma granarium*.

(2) It has been possible as a result of research to advise growers of improved methods of control of many agricultural pests notable among such being the coastal stem borers of maize (*Chilo zonellus* and *Chilotraea argyrolepia*) Barley Bulb Fly (*Hylemyia arambourgi*), Thrips and Red Spider Mite on pyrethrum, various insect pests of cotton, and the Bean Fly (*Melanagromyza phaseoli*).

(3) The Colonial Development and Welfare Fund research project on the systematics of the Coccidae continued to prove of great value to entomologists in East Africa and other parts of the world.

(4) Sugar Cane Smut (*Ustilago scitaminea*) was recorded for the first time in East Africa and this has made necessary a revision of the approach to cane varieties for local use.

(5) Work on potato varieties with particular reference to blight resistance and general field performance has been increased in view of the growing interest in this crop.

(6) The most serious disease of potatoes is Bacterial Wilt (*Pseudomonas solanacearum*) and more intensive research on this disease is planned.

(7) A special survey of the Blotch and Scald diseases of barley was carried out following serious damage to the crop. The fairly widespread system of monoculture of cereals is believed to be of prime importance in encouraging these and certain other cereal diseases.

(8) A steady increase in the valuable work of the Seeds Laboratory continues.

(9) Although staff shortages have limited the desired expansion of legume inoculant research good progress in this field can be recorded.

(10) The item of major importance in the soil science field was the impetus given by the I.C.A. Soils Team under Dr. James Thorp, Senior Soil Classification Specialist and Dr. Adolf Mehlich, Soil Chemist. The soil surveys for sugar development in the Songhor and East Konyango areas deserve special mention. While these surveys obviously have an immediate practical value from the viewpoint of local development, the work of the American Team at these places and elsewhere in the Colony has been of very great value in helping to set a pattern for future soil survey work in Kenya. A Soil Surveyor was recruited to the Kenya staff during the visit of the American Team and the experience this officer gained by working with the Team should be of great importance to future work in this field. Dr. Mehlich was responsible for the organization of an improved soil testing service with a greatly enhanced capacity. I.C.A. funds have also been provided to improve research facilities at the Scott Agricultural Laboratories. This very generous American assistance is gratefully acknowledged and has played a most important part in our plans to improve the service to the farmer in this field of work.

(11) The year saw the opening of fine new laboratories and offices at Njoro to house the plant breeding team and the expanded programme of cereals research made rapid progress during the year.

(12) The Plant Breeder at Katumani Experimental Station, Machakos, showed very satisfactory progress towards the development of short-term maizes and the first promising type called Taboran was bulked for release to farmers.

(13) A greatly expanded programme of coffee research, under financial support from the coffee industry, made considerable progress during the year. New coffee research substations were opened in Upper Kiambu and at Koru thus providing a wider coverage for investigational work under the diverse conditions under which coffee is grown in the Colony. Important advances were made in our knowledge of magnesium imbalance with particular reference to the application of grass mulches with high and low potash content. The work of the research officer appointed to ensure that the benefits of coffee research are quickly made available to African growers is proving of great value. The Coffee Berry Disease Research Unit makes steady progress and arrangements have been made for this unit to take over most aspects of research on Leaf Rust (*Hemileia vastatrix*).

(14) A number of promising new varieties of Rhodes and Molasses grasses are now ready for testing under farm conditions. The breeding behaviour and the variation within main types of various ley grasses are being studied to form a basis for future plant breeding work and early indications are that this field of research is likely to offer very rewarding and indeed quite spectacular results. Evaluation of species and strains of grasses and clovers for high altitudes has made good progress though here again the science of plant breeding is going to be required to develop types adapted to local needs. Soil fertility studies aimed at improving the production of grasses and clovers, including more effective nitrogen fixation by *Rhizobium* bacteria, continued to receive special attention.

(15) A survey of the main ranching areas has been completed.

(16) The work of Pasture Research Officers stationed at Marigat and Katumani is developing rapidly and merits special study by those interested in the problems of the drier areas.

(17) The headquarters for horticultural research has been transferred from Molo to Thika. Special investigations into the production of citrus juice for export are being conducted and considerable attention has been given to the question of export of horticultural produce by air to the United Kingdom and elsewhere. Research continues with a very wide range of products.

(18) Improved seed supplies of better planting material are now available to pyrethrum growers and sound advice can now be given on many questions affecting the efficient production of this crop, e.g. general cultural methods, use of fertilizers, control of Thrips and Red Spider Mite, picking standards, etc. It is important now for a greater effort to be made to get our enhanced knowledge adopted by a much higher proportion of growers. The importance of plant breeding as a source of further improvement is fully recognized and progress in knowledge of the four main constituents in pyrethrum flowers indicates that the plant breeder can be progressively directed more accurately to what the industry requires.

(19) Again in sisal research our policy is to strengthen the contact between the Department and growers so that the findings of research can be tested and applied in practice as quickly as possible. Here the accent is very strongly on economics, i.e. the need to use every possible means of reducing cost of production.

(20) Irrigation research has continued at Mwea, Hola and Perkerra and the development of a small new station at Ahero on the Kano Plains is nearing completion.

(21) On the general investigation stations in Provinces work has continued to cover a very wide field of research on food and cash crops. Work on animal husbandry problems has been steadily increased and this trend must continue. In fact it is becoming very apparent that a central organization for animal husbandry research on commodity station lines is badly needed to co-ordinate and control the work in progress all over the country. Considerable and very satisfactory progress has been made in deciding and implementing stock policies for all stations and the standard of stock carried on departmental farms is good, in some cases quite outstandingly so as reference to the prize lists of the Shows of the Royal Agricultural Society of Kenya will confirm.

Great importance is attached to work on food crops. Here the skill of the Plant Breeder can be brought to bear though it is of little avail until standards of general culture, weeding, use of fertilizers, control of pests, etc., make parallel progress and steady improvement in these directions can be recorded.

As a Department our first function must be to assure the food supply of the people and to aim at improving the nutritional quality of the diet. Africans are very conservative in matters of diet but progress is being made in widening the diet and here animal products, especially milk, are playing a very important part. In fact the appreciation by the African of the value of milk for his children is one of the most important features in the present period.

A great deal of attention is being given to the improvement of existing cash crops and a very intensive scheme to evaluate potential new cash crops is under way. Turkish tobacco, lentils, Soya Beans, jute and *Sesamum angolense* (source of a pyrethrum synergist) are good examples of this type of activity.

In African agriculture the need to examine and evaluate existing material is stressed. There is danger in the attitude that the plants we grow must always be new and accordingly it is important to evaluate local material and ensure that anything of value is preserved. Cases in point are to be found in local cereals (maize, sorghum, millets), bananas, sweet potatoes and groundnuts, and it would be a tragedy if the potential value such might contain were to be lost. In the cash crop field there is also a strong case to attempt to exploit indigenous material and this is being borne in mind. Examples are *Rauwolfia mombasiana* (a potential drug plant) *Ensete edulis* (as a source of fibre) and *Catha edulis* (locally known as "Miraa", which is a stimulant appreciated by certain tribes since ancient times).

In general it can be claimed that the organization of the research division has shown steady improvement. The quality and enthusiasm of the staff of the division is a source of great satisfaction because as in other walks of life this is the major key to success.

Results of value to our farmers are steadily being obtained and these are transmitted rapidly into practice through the extension service. Reference to the publications noted in our Annual Reports will confirm that the flow of information has reached a very high level. Currently, local financial difficulties are limiting further progress in some spheres and this is a source of great disappointment at a time when everything was set for highly profitable expansion of our research activities, but every effort is being made to keep important projects going as efficiently as possible. Some sections have benefited from financial assistance from local producer bodies, the Colonial Development and Welfare Fund, the International Co-operation Administration of the U.S.A. and the Rockefeller Foundation and we are extremely grateful for this assistance. I should like to take this opportunity to express my thanks to the members of the research and advisory committees in all branches which have played such an important part in developing the research effort in this Colony. The formation of these committees has brought us closer to the farmer and his problems and their work helps us to keep our feet very firmly on the ground. At the same time farmer members do I think gain a useful appreciation of some of our difficulties which leads to a much better understanding between us.

In conclusion I should like to thank Mr. G. W. Nye, C.M.G., O.B.E., Mr. G. M. Roddan, C.M.G. and Mr. D. Rhind at the Colonial Office for the help they continually give us on research matters; the Directors of E.A.A.F.R.O.,

E.A.V.R.O., E.A.I.R.O., the Director of the Tropical Products Institute in London, the Director of Kew Gardens, the Director of the Empire Cotton Growing Corporation, the Directors of the Commonwealth Agricultural Bureaux organizations and many other organizations for their valuable assistance. I should also like to thank the Directors of Agriculture of the East African territories and their Chief Research Officers for their ready co-operation in matters affecting our programme which is greatly appreciated. Finally, I should like to thank all officers of the Research Division for their hard work and enthusiasm which has been a source of very great satisfaction to me.

A. R. MELVILLE,
Chief Research Officer.

ANNUAL REPORT OF THE SENIOR ENTOMOLOGIST, 1958

The headquarters at the Scott Agricultural Laboratories was the administrative centre, with work on storage of maize, Coccid taxonomy, plant protection services and advisory work being carried out there.

The Coast Entomologist, based at Matuga, worked on pests of coconuts, cotton and cereals. Nyanza problems of cotton and other native crops were studied by the Entomologist stationed at Kibos.

Pests of high altitude crops in the Rift Province were dealt with by the Entomologist based on Nakuru. The Entomologist (Stored Products) was based at Kilindini where he worked on infestation of cargoes and ship inspections.

The Coffee Entomologist was based at the Coffee Station, Ruiru; his report is included under that station.

Plant Protection Services

New Legislation

No new legislation was drafted. The East African Standing Technical Committee worked on a new schedule of rules common to all East African territories to fit the requirements of the Inter-African Phytosanitary Commission.

Importation of Plants

Parcels inspected through the Post Office totalled 1,584 as compared with 2,520 for 1957. Plant Importation Permits issued fell from 1,812 in 1957 to 1,544 in 1958. It is evident that less plant material was imported into the Colony during the year.

Export of Plant Material

Horticultural produce, consisting of pineapples and fresh vegetables, was inspected for export by air to the United Kingdom, Mogadishu and Aden. Pineapples for export by sea to Aden and Persian Gulf ports were also inspected at the Horticultural Co-operative Union godown. The number of export certificates issued during the year was 286, showing an increase of 57 over the 1957 figures.

Fumigations

Very few fumigations were carried out of export material during the year. Methyl bromide was used to fumigate stored products.

Insects Intercepted

The following insects were intercepted:—

Chrysomphalus ficus (Ashmead) from South Africa on oranges.
Aonidiella aurantii (Mask) from India on oranges.
Parlatoria? from India on oranges.
Lepidosaphes beckii (Neum) from India on oranges.
Aonidiella aurantii (Mask) from South Africa on oranges.
Phoma citricarpa from South Africa on oranges.
Phoma sp. from India on orchid plants.
Lepidosaphes beckii from South Africa on oranges.
Tribolium castaneum from Denmark in barley seed.
Oryzaephilus surinamensis from India in rock melon seed.
Parlatoria sp. from Israel on lemon.

VISITS

Mr. Duncan carried out trials on colouring pineapples with ethylene. Sufficient data was obtained to enable Messrs. Kenya Canners Ltd. to build their own gassing chamber in order to colour fresh pineapples intended for export to the United Kingdom market.

Between 1st May and 22nd November Mr. Duncan was absent on long leave. During his leave he visited Italy, Germany, Holland and Belgium in order to investigate the possibility of exporting pineapples and other fresh fruit to these countries.

ACKNOWLEDGMENTS

Thanks are given to the staffs of Customs and Excise Department and the General Post Office for their helpful co-operation. Thanks are also given to the staff of East African Airways Corporation for all their help throughout the year.

Stored Products

The Pest Infestation of Stored Products Committee held two meetings during the year.

Mr. F. Ashman, Stored Products Entomologist, joined the staff in August. He is on the staff of the Department of Agriculture but his work is co-ordinated with that of the Maize Control entomological staff by the Pest Infestation of Stored Products Committee.

Mr. Kockum, Scientific Officer (Stored Products) of Maize Control, was on vacation leave during the year, while Mr. W. M. Graham, Stored Products Entomologist of Maize Control, was absent at times through illness. They report as follows:—

Fumigation experiments with methyl bromide were again the main feature of the year's work. Studies of gas distribution in stacks covered with gasproof neoprene sheets were continued but with the emphasis on the more practical aspects of the work.

Several stacks of maize were covered with light polyethylene sheeting (0.0025 inch thick) and fumigated. The polyethylene was then left in place for the storage period as a barrier against reinfestation. This technique appears most promising and larger trials are anticipated. Though the polyethylene is not as gas-tight as neoprene sheeting the gas losses are not significant when large stacks are thus treated.

The Maize Control shell concrete store in Nairobi—the Ctesiphon—was rendered gas-tight and methyl bromide gas was released directly into the store for a five-day fumigation of about 100,000 bags of badly infested maize. The results were excellent: the infestation in the stacks was controlled, the stores residual beetle population was killed, flying moths were controlled and the cost was less than that which would have been incurred had the individual stacks in the store been fumigated under gasproof sheeting. From the technical aspect the most important points were the small amount of gas needed and the thoroughness of the gas distribution though no expensive gas recirculating equipment was used.

Further crib experiments were set up in 1958 but results will not be available until 1959.

One of the purposes of the experiment is to discover the effect of coumarone resin in the resin/lindane/kerosene spray which is applied to the hessian covering of the crib wall (*see* 1957 report).

Bagged maize and wheat has rarely been dusted adequately with 0.5 per cent lindane during stacking. The primary reason is that the recommended application of three ounces per bag causes too great a dust nuisance. An experiment on dust penetration has been carried out where bags of grain were dusted and the recommendation has been altered to 1½ ounces of 1 per cent lindane in diatomite dust. Maximum penetration of the dust with the grain amounts to less than one part per million of lindane which thus presents no hazard to the consumer. The full quantity of 1½ ounces must be applied to be effective against insect pests.

An experiment was set up using individual bags to determine the efficiency of dusting with 1 per cent dust at different rates. This will be terminated in 1959.

Infestations of *Trogoderma granarium* were found on many ships arriving in Mombasa from the Far East and cargoes from these ships have often to be fumigated. A survey was made of the Port of Mombasa to ascertain whether this dangerous pest has established itself. No infestation was found.

Alleged fumigation failures at Mombasa were investigated and it is believed that rapid reinfestation by *Tribolium castaneum* occurs. A study of this reinfestation is to be made.

Another pest of stored products, *Araecerus fasciculatus*, was found breeding in a decaying paw-paw tree near Mombasa.

Inspections of up-country wheat, on behalf of the Wheat Board, were made by Messrs. Ashman, J. F. Graham and W. M. Graham.

The inspection of ships' cargoes for insects was carried out during the months September to December, 1958. The commodities inspected and insects found are briefly outlined as follows:—

Cereals and Cereal Products

Tribolium castaneum, Oryzaephilus surinamensis, Ephestia cautella and *Calandra oryzae* were most frequently found in general on these products. Less frequently found, yet nevertheless of considerable significance so far as damage caused goes, are *Tenebroides mauritanicus* and *Corcyra cephalonica.* Species found least frequently were *Ahasverus advena, Alphitobius diaperinus, Carpophilus* spp. *Ephestia kuhniella, Plodia interpunctella, Rhizopertha dominica* and *Trogoderma granarium. Cryptolestes* spp. appear to be increasing in distribution although they have not yet been seen in large numbers in a commodity here at Mombasa.

Oilseeds and Oilseed Cake

Tribolium castaneum occurred most frequently on oilseeds in general and can at times cause considerable damage to certain commodities, groundnuts for example. *Oryzaephilus mercator* and *Necrobia rufipes* appear restricted mainly to groundnuts and copra. *Carpophilus* spp. deserve special mention: they are usually found in mouldy produce and may at times occur in large numbers and larvae often appear in "pools" between sacks or at the base of stacks. *Necrobia rufipes* is often associated with *Carpophilus* or mouldy oilseed. It preys on *Carpophilus* larvae and as a result of an increase in developmental and oviposition rate cause considerable damage at times. *Tenebroides mauritanicus* can become a serious pest of certain oilseeds at times. Other species found on oilseeds with less frequency were *Cryptolestes* spp. *Lophocateres pusillus, Araecerus fasciculatus, O. surinamensis, C. oryzae, Stegobium paniceum, Alphitobius diaperinus, Dermestes ater* and *Xylocoris flavipes.*

Pulses

Bruchids were the most frequently found pests of pulses, *Calosobruchus chinensis, C. maculatus* and *Acanthoscelides obtectus* being the commonest species occurring. *Bruchus lentis* was often found on lentils from the Lebanon. The dermestid *Trogoderma granarium* was found in dried peas from India on one occasion. *Tribolium castaneum* and *Oryzaephilus surinamensis* occurred in pulses on occasions.

Coffee

In general coffee was found free from insects; however, *T. castaneum* has been found infesting coffee on occasions. A *Coptotermes* species was found attacking sacks of coffee on one occasion.

Spices

The tobacco beetle *Lasioderma serricorne,* the drug store beetle *Stegobium paniceum,* the khapra beetle *Trogoderma granarium,* and the red rust grain beetle *Tribolium castaneum* were found in equal frequency on spices in general. *L. serricorne* and *S. paniceum* are endemic species in Kenya and frequently bring about serious loss in weight in spices. *Thaneroclerus buqueti* is a predatory clerid occurring alongside these species. It would be unjustified at this stage to generalize too much on the data available. However, certain conclusions can be safely drawn. *T. castaneum* is without doubt most frequently found in general on certain foodstuffs inspected. *O. surinamensis* and *E. cautella* appear in equal consistency. *C. oryzae,* though found less frequently in cargoes in general, should be classified with the above as a major pest species. *Cryptolestes* spp. and *T. mauritanicus* were next in order of abundance, the latter species doing considerable damage to certain commodities. Not much biological data is available for *T. mauritanicus,* and its true status as a pest is far from clear.

Pests of Agriculture

No major outbreak of an insect pest occurred during the year, but some concern arose through attacks by weevil larvae of the *Nematocerus* complex on the roots of tea seed in the Sotik area. These larvae also attack wheat in the Naro Moru area as mentioned below by the Entomologist in the Rift Valley Province, and further attempts are to be made to control them in the coming year.

The investigation into rice stem borer *Maliarpha separatella* (formerly *Rhinaphe vectiferella*) on the Mwea Irrigation Scheme continued. Light trap counts were made throughout the year by the Agricultural Officer (Irrigation Research) and showed presence of the adult moths throughout most of the year: few were recorded from mid-September to the end of October.

The tendency was for more larvae to occur in the later plantings than in early ones. As no build-up in numbers of adults occurred through the year it would appear that conditions are better in later plantings for the attainment of the larval stage.

It was established statistically from numerous samples taken from the main Mwea/Tebere scheme that the number of empty heads of rice was unrelated to the presence of borers. The number of empty heads bore a relation to the number of tillers, e.g. one empty head in a plant with ten tillers and 39 empty heads in a plant with 45 tillers. The possibility that tillering is stimulated by the presence of borers requires investigation. Susceptibility of varieties to borer attack was not statistically significant. A spraying trial to measure increase in yield due to borer control failed due to lack of borers on the control plots. The effect of the borer on the crop continues to be problematic and further investigations are planned for 1959.

A case-bearing caterpillar occurred in the rice for the first time: its identity is awaited. Good control of it was achieved by the use of D.D.T.

The ant and mealybug control experiments on pineapples at Thika continued, but the degree of ant control achieved by overall spraying of D.D.T. or Dieldrin was disappointing and cannot be recommended to the planter.

A small trial of methyl bromide fumigation of planting material showed that development of the plant is slowed up with increasing dosage. As there seems little chance of this method becoming widely adopted no further work is being carried out, and dipping the material for five minutes in 0.05 per cent Diazinon remains as the practical recommendation.

A little work on Sudan Dioch (Quelea) showed that a standing crop of wheat can be converted into a bait by spraying with dieldrin which proves fatal to the birds. By harvest time this deposit of insecticide would break down and the crop could be safely harvested.

Topical application of parathion suggested that a gassing effect is obtained where a roost was sprayed and that deaths are not due to contact effects of parathion.

Mr. Wheatley, Entomologist, Coast Province, reports as follows:—

The Coreid Bug of Coconuts

The main work has been on the coconut coreid bug, *Pseudotheraptus wayi*. An experiment to determine the loss of crop which can be attributed to *Pseudotheraptus*, started in 1957, has continued throughout the year. Spraying began in February, and despite massive interference from immigration of insects into the plots, effective control has been maintained at an average of 70 per cent. A marked increase in the number of developing nuts can now be seen in the sprayed block, and the December harvest showed a 50 per cent increase in yield over the central block.

Bio-assay work with several D.D.T. formulations, dieldrin, B.H.C. and pyrethrum has been carried out during the year and is now nearing completion. Using an "Agla" syringe for topical application, dieldrin has been shown to be about five times as toxic to *Pseudotheraptus* as D.D.T. The insect is relatively highly resistant to pyrethrum, whether synergized or not, although the use of piperonyl butoxide as a synergist at eight times the pyrethrum content increases toxicity fourfold. Although pyrethrum gives a quick knockdown at high dosages, activation of the insect is not very marked, and it appears unlikely that addition of pyrethrum to other contact sprays will markedly increase their effectiveness. Biological assays of residues at different times after application of a variety of residual insecticides have shown dieldrin and D.D.T. to be the two most promising. Absorption of D.D.T. has been investigated and found to be of no great significance. For the different formulations, an emulsion and a crystalline suspension, applied as full cover sprays at 0.5 per cent active ingredient, only 20 per cent to 40 per cent of the D.D.T. was absorbed.

Many substances were tested in an effort to find an attractant for *Pseudotheraptus* to enable the formulation of poison baits, but none were discovered. Four systemic insecticides were assayed biologically with disappointing results.

Cotton Pests

Damage caused by insect pests on well-grown cotton at Msabaha was assessed at Sh. 275 per acre as compared with Sh. 453 in 1957. The decrease is attributed to a lighter stainer attack and lower cotton prices. American bollworm appeared

in unusually large numbers during July and did a great amount of damage, but this was largely offset by the plants producing compensatory bolls and a remarkably light pink bollworm infestation.

In a dusting trial, D.D.T./W.C.I. was found to be superior to both D.D.T./malathion and endrin/malathion. No pronounced red spider build-up occurred this year and it was therefore not possible to compare these dusts for acaricidal properties. At Hola, sprays of endrin with or without malathion and D.D.T. with B.H.C. proved superior to toxaphene and D.D.T. with malathion.

Maize Stem Borers

As assessment of the damage caused by the coastal stem borers, *Chilo zonellus* and *Chilotraea argyrolepia*, over the last two years gave variable results at Matuga where yields were low, but at Msabaha and Hola, where yields of unprotected maize were in the region of eight bags an acre, control of stem borers by spraying with D.D.T. and endrin increased yields by $2\frac{1}{2}$ bags (34 per cent), this increase being highly significant.

Castor Oil

A survey was carried out of the insect pests of castor. Mirid and pentatomid bugs, including *Nezara* spp. *Acrosternum* spp. *Lygus* spp. *Adelphocoris apicale* and *Eurystylus capensis*, were found to feed on the flowers and developing seed, causing abortion and allowing entry of a fungal dieback of the inflorescence. These pests cause very great losses in the wetter parts of the coast. The small wingless grasshopper *Chrotogonus* sp. frequently attacks the young seedlings soon after germination. Of several leaf-eating caterpillars, *Euproctis producta* is the most common. A *Jassid, Empoasca* sp., causes distortion of young leaves, whilst red spider and thrips frequently cause total defoliations: fortunately this normally occurs after harvesting has been completed.

Ratooning of castor is rarely successful due to severe attack by scale, mainly *Aonidiella andersoni*, and the stem borer, *Xyleutes capensis*. Of many seed-boring lepidoptera, *Argyroploce leucotreta* and *A. wahlbergiana*, are the most common.

In a trial at Matuga, regular weekly spraying against the mirid/pentatomid complex gave adequate control and led to a large increase in yield, but the economics of castor spraying are not yet known.

The parasite, *Eretmocerus serius*, has been imported from the Seychelles and released at Matuga for the control of citrus blackfly, *Aleurocanthus woglumi*. Establishment has not yet been confirmed.

Mr. J. A. Bullock, Entomologist, Rift Valley Province, reports as follows:—

The majority of the experimental work has been concerned with barley fly (*Hylemyia arambourgi*), pyrethrum thrips (*Thrips* spp.), pyrethrum red spider mite (*Tetranychus ludeni*) and the larvae of *Nematocerus* sp. In addition, experiments on maize stalk borer (*B. fusca*), chafer grub (*Schizonycha* sp.) and another chafer (probably *Heteronychus* sp.) have been done.

Barley Fly (*H. arambourgi*)

Large-scale trials were conducted on five farms in Rift Valley, testing aldrin, dieldrin and endrin dry seed dressings, and aldrin applied in a slurry with methyl cellulose. One farm failed to sustain an attack, whilst the barley on another was wiped out by *Helminthosporium teres*. On one of the remaining three farms good control was obtained with all four treatments, whilst on the other two endrin and aldrin appear less effective than dieldrin and aldrin plus methyl cellulose, although this difference was only well marked with aldrin on one farm.

Aldrin, dieldrin, endrin, heptachlor, Thiodan and thiometon seed dressings were tested in a small experimental plot and heptachlor and dieldrin gave a high degree of control, whilst aldrin and endrin appeared less effective, and thiometon and Thiodan had no effect on the infestation.

Aldrin, gamma B.H.C. and dieldrin, with and without a phenyl-mercurial fungicide, were compared in a second experiment. No effect from the fungicide was found, but dieldrin was greatly superior to all other treatments whilst aldrin was better than gamma B.H.C.

In a further trial, aldrin wettable powder was mixed at three different rates with a phosphatic fertilizer and applied at the time of planting. No better control was obtained with these treatments than with the aldrin seed dressing.

A test of various methods of control showed a dieldrin spray applied three days after emergence of the coleoptile, to be superior to an aldrin seed dressing, an aldrin/fertilizer mixture and a dieldrin spray applied after an infestation had developed.

Sprays of various insecticides were applied to barley carrying a 25 per cent infestation and Phosphamidon and Rogor produced a decrease in infestation. The reduction was not considered sufficient to be economic, and it is apparent that any satisfactory control requires the elimination of the larvae prior to their entering the plants.

A test of dieldrin seed dressings, applied at different rates, showed that treatments as low as 2 oz. active ingredient per 100 lb. seed gave a fair measure of control but that 5 oz. active ingredient per 100 lb. was rather superior.

Larvae of *H. arambourgi* were found attacking Nandi Setaria seedlings, and caused considerable damage to a small plot at Nakuru.

Data obtained during the previous two years was examined together with that collected during the current experiments. The analysis is not yet complete, but preliminary results show a significant correlation between percentage infestation and yield, and that the frequency of attacked shoots per plant on unprotected barley shows a Poisson distribution, with the numbers of plants with nil and one attacked shoots high.

The known range of the fly was extended, infestations being confirmed in the South Kinangop and the Trans Nzoia.

PYRETHRUM THRIPS (*Thrips* spp.)

A trial at the beginning of the year showed that thrips could be controlled with sprays of D.D.T. or of dieldrin and that two applications at approximately a fortnight's interval were necessary. Three weeks after spraying a second time, the recorded population was still very low, but a heavy outbreak of a mite, *Tetranychus ludeni,* had occurred. A number of growers have also recorded heavy infestations soon after spraying against thrips and it is presumed that the use of persistent insecticides has resulted in the elimination of agents controlling the mites. A trial was put down using schradan and chlorobenzilate, but counts one and three weeks after treatment failed to show any reduction in population. The schradan treatment was observed to have greatly reduced the residual thrips population.

In a further experiment on control of thrips, malathion was shown to have no effect on the population, whilst Rogor gave some reduction in numbers but could not be regarded as efficient. Endrin with two applications was as effective as D.D.T.

Two further experiments were invalidated by sudden decreases of population due to weather conditions.

A satisfactory method of extracting thrips from samples of leaves has been developed, using a technique involving the use of a benzene-water interface. This method has been adopted for the use of farmers and should provide a useful indication of the population of a field.

NEMATOCERUS sp.

Severe damage was caused to barley and wheat in the Naro Moru and Moyo Ridge areas. Two isolated cases of damage were also recorded in the Uasin Gishu and Trans Nzoia. Insecticides have so far had little effect. A trial on oats, intended for chafer control, involving seed dressings of dieldrin (2.5 oz. a.i. per 100 lb.), aldrin and gamma B.H.C. was completely destroyed by *Nematocerus*, whilst plots in an observation trial, using lead arsenate, Sevin and gamma B.H.C., were also destroyed. Three insecticides, dieldrin (8 oz. a.i. per 100 lb. seed), heptachlor and thiometon, gave some control but cannot be considered very effective.

No experiments have been possible on cultural control, but observations show that where a crop has been completely destroyed no attack occurs on the next season's planting, whereas land which has carried a medium or light infestation in one season is heavily attacked in the next. It has therefore been suggested to farmers that a rule of one crop per annum off any one field should help to achieve control. In addition, crops planted two to three weeks before the onset of the rains appear to be sufficiently well grown to withstand an attack which does not occur until just after the rains begin.

MAIZE STALK BORER (*B. fusca*)

A trial on the hand application of dieldrin and endrin granules and aldrin and dieldrin dusts sustained only a slight infestation, but all treatments were better than the control.

A combined insecticide/herbicide spray was applied to maize 6 in. high. The herbicide was effective and caused little damage, but since no insect attack occurred the primary purpose of the trial was invalidated.

CHAFER (*Schizonycha* sp.)

Of three trials put down, two sustained no attack, whilst the third was destroyed by larvae of *Nematocerus* sp.

EQUIPMENT

A jeep has been converted for spraying, by fitting a power take-off. The spray unit consists of a "Hypro" pump and a Fison's "Weedmaster" spray boom. This was used successfully on insecticide spray trials, and was also used in fungicide and herbicide work for the Nakuru district.

Work in Nyanza was taken over by Mr. Davidson from Mr. Crowe in September. They report as follows:—

As in previous years the main research project was the control of cotton pests. Since, however, it is hoped to increase the acreage of passion fruit grown in Nyanza Province, and since the virus disease, "woodiness", is the most important factor limiting expansion, work on the aphid vectors of this disease was given second priority. Collaboration was maintained with the Agricultural Officer (Research) at Sotik in all woodiness work.

Cotton

As the cotton season is not yet finished, full results will be published in the Empire Cotton Growing Corporation Progress Report (Kenya 1958-59).

District trials on African-grown cotton have shown that pest attack can be strikingly reduced by the use of insecticides. Results so far available from the lakeshore area show yields increased from 290 lb. seed cotton per acre (50 per cent stained) to 700 lb. per acre (20 per cent stained) by either 60 or 80 lb. of a 3 per cent gamma B.H.C./10 per cent D.D.T. dust. In both treatments the insecticide was applied in five equal lots at ten-day intervals.

In the wetter Elgon Nyanza areas spraying of 4 lb. of D.D.T. per acre (four applications at ten-day intervals) increased yields of April-planted cotton from 290 lb. per acre to 630 lb., and of May-planted crops from 360 lb. to 490 lb. Results from June plantings are not yet available, but inspection of the crops in the field suggests that these will confirm the need for early planting to benefit from the use of insecticides and, conversely, the need to use insecticides on early planted cotton. These district trials roused considerable interest among farmers and it was decided to encourage commercial distributors to market cotton insecticides in the province next season.

A trial was put down at Busia in Elgon Nyanza to compare the standard D.D.T. spray (applications of three pints of 25 per cent D.D.T. emulsifiable concentrate in eight gallons of water per acre) with the same weight of D.D.T. in higher volumes and made up from wettable powders. The standard treatment produced the highest yield but differences were not statistically significant. Trials were planted at Kibos and Busia to determine whether the widespread practice of inter-planting beans in the cotton reduces cotton yields sufficiently to make the use of insecticides uneconomic. Inter-planting caused no reduction of cotton yields at Kibos and some increase at Busia. It would appear that provided both crops are planted early in the long rains there is sufficient soil moisture at that time for both. The use of insecticides is only economic on timely planted cotton with reasonable standards of soil fertility and cultivation. The effect of caging chickens on cotton plots was investigated at Kibos in the hope of finding a method of pest control for the large numbers of growers whose cotton does not justify the use of insecticides.

The trial was severely attacked by termites soon after planting and this resulted in a stand of very large plants. Excellent stainer control was obtained. The percentage of stained cotton decreased as the number of chickens per acre was increased as follows: 61.3 per cent (no chickens), 53.9 per cent (7.5), 54.9 per cent (15), 52.4 per cent (30), 52.2 per cent (60), and 46.2 per cent (120). Yields, however, were very variable and differences not significant. There was no evidence that the number of any pest but *Dysdercus* spp. was reduced by the chickens.

Passion Fruit Woodiness

Aphids of several species have been found feeding on passion fruit at Sotik. Aphid trays of the "Moericke" type (shallow, chrome yellow tray filled with water) were set up both inside and outside passion fruit plantations at Sotik. Trapping records show that aphid numbers increase considerably in periods of low rainfall.

Attempts to transmit woodiness from infected passion fruit, *Passiflora edulis*, to pomme d'or, *Passiflora ligularis* (which Dr. Nattrass has shown to be a useful indicator plant), have not so far been successful. At present the Sotik planters

raise passion fruit seedlings near infected plantations this may account for the early age at which their plants show symptoms of woodiness. A trial which includes the raising of seedlings in isolation from infected plants is being laid down at Sotik Experimental Station.

Other Crops

Efforts are being made by a group of farmers in the Songhor area to produce high-grade citrus, especially oranges. Surveys in the area have shown that the most serious pests are false codling moth (*Argyroploce leucotreta*) and various species of mites which blemish the skin and lower the grade. Rogor at 0.1 per cent active ingredient gave good rust mite (*Phyllocoptruta* sp.) control at Kibos, but not of the red spider mite. Tedion is now being tried against the latter. Growers have agreed to co-operate in keeping records of false codling moth damage so that a more accurate assessment of the status and seasonal activity of this pest can be obtained.

Trials of cultural and chemical methods of control of the banana weevil (*Cosmopolites sordidus*) continued at Busia. Growth responses to the mulch treatment were very striking. A report of this occurrence of this pest in the Kisii area could not be confirmed.

Damage to the roots of tea seedlings in nurseries at Sotik was caused by larvae of *Nematocerus* spp. and other weevils. Attempts to kill the larvae by watering insecticides into the soil have not been successful. Maize meal and molasses baits with B.H.C. or malathion have been successful in killing adults, and since these are wingless, barrier baiting round the nursery beds may prevent further infestations.

Collection of local varieties of sweet potatoes, with their vernacular names, have been established at Kibos and Busia. Preliminary observations suggest that, as has been reported from other countries, some varieties are resistant to the sweet potato weevil, *Cylas puncticollis*. Further experiments are going on.

Trials at Kibos and Busia to find out the optimum rate of aldrin for seed dressing beans against the bean fly, *Melanagromyza phaseoli*, failed in their main object because of the low incidence of the pest at both stations. In a trial at the Scott Agricultural Laboratories aldrin proved superior to both B.H.C. and dieldrin.

Biological Control of Weeds

The Tingid bug, *Teleonemia scrupulosa*, was liberated on Lantana at Kibos early in the year. It is well established but appears, as elsewhere in the Colony, to be inflicting negligible damage.

The Lantana seed fly, *Agromyza lantanae*, was obtained from Hawaii and was liberated in June at Fort Hall and in Nairobi. Recoveries were made within two months and the fly, which breeds in the berries, now appears to be established over a wide area. The cochineal, *Dactylopius tomentosus*, brought in from Tanganyika, was reared in Nairobi and at Kibos. Liberations were made in Nairobi, at Naivasha, Mariakani and Mohoru Bay. It appears to establish itself slowly and results are not expected for at least two years.

Systematic Study of Coccidae

Mr. G. De Lotto, Entomologist (Taxonomy), reports as follows:—

The study of the species of *Coccus*, hitherto not revised, from Africa south of the Sahara, has been completed and sent to the Press.

A supplementary study of the coffee green scale complex from the same area has been carried out and is nearly completed. From the study it is apparent that *Coccus africanus,* the common green scale of coffee, consists of a group of distinct species. The work on *Ceroplastes* has been carried out and is approaching completion. It will cover all species in the Ethiopian region mentioned above.

Work is also in progress on a paper describing new species of mealybugs from Africa south of the Sahara.

Routine work on identifications of coccid material from various parts of Africa was carried out throughout the year.

Publications

Bullock, J. A.—

Pyrethrum thrips and Red Spider Mite, *Kenya Farmer,* June, 1958, p. 23.

Barley Fly, Black Wheat Beetle and Maize Stalk Borer. *Kenya Farmer,* April, 1958, p. 25.

Crowe, T. J.—

Progress Reports from Experimental Stations (Kenya, 1957/58). Empire Cotton Growing Corporation.

De Lotto, G.—

A new species of Saissetia from South Africa (*Homoptera*: *Coccoidea*: *Coccidae*). *J. Ent. Soc., Sthn. Africa.* 21. 66-68.

The Pseudococcidae (*Homoptera Coccoidea*), described by C. K. Brain from South Africa. *Bull. Brit. Mus.* (*Nat. Hist.*). *Ent.* 7. 77-120.

New Soft Scales (*Homoptera Coccoidea Coccidae*) from Africa. *Proc. Roy. Ent. Soc.,* Series B., Vol. 27. p. 165-172.

Graham, W. M., and Kockum, S. P. L.—

Protection of bagged maize with Lindane and D.D.T. *Trop. Agric.,* Vol. 35, p. 292.

Fumigation under a polyethylene envelope. *Nature,* Vol. 181, p. 1675.

Kockum, S. P. L.—

Control of insects attacking maize on the Cob in Crib Stores. *E. Afr. agric. J.,* 23, p. 275-279.

Maitai, W. M.—

Annotated List of Insects associated with the Sweet Potato (*Ipomoea batatas*). *E. Afr. agric. J.,* 23, p. 290-291.

The production of advisory leaflets continued.

Acknowledgments

Thanks are due to the Commonwealth Institute of Entomology for their continued help with the identification of insects.

J. F. GRAHAM,
Acting Senior Entomologist.

ANNUAL REPORT OF THE SENIOR PLANT PATHOLOGIST, 1958

The retirement of the Senior Plant Pathologist, Dr R. M. Nattrass. took place in July. This accentuated an already difficult staff shortage and some curtailment of the intensity of the work of the Section has been inevitable. The field covered by the Plant Pathology Section continues to expand, however, and, with the appointment of an A.A.O. (Potatoes), the potato work is now recognized as a separate subsection making a total of five subsections; these are: plant pathology, legume bacteriology, seed testing, potato work and wheat stem rust pathology. In March, Dr. E. J. Guthrie moved to the new laboratories at the Plant Breeding Station, Njoro, taking with him all the wheat stem rust work. He remains a member of the Plant Pathology Section but his report is included in that of the Senior Plant Breeder.

1958 proved a bad year for plant diseases and losses from many common diseases were abnormally high. Many diseases such as *Pyrenophora tritici-repentis* and *Septoria* spp. on wheat and the leaf blotches of barley, which, in previous years have been considered of little significance, assumed serious proportions. July and August, in particular, were favourable for the development of plant disease epidemics and considerable damage resulted.

During the year, a record number of 526 plant pathological specimens were examined in the laboratory. Of these, 95 were sent in by members of the public, 148 were brought in by visitors to the Laboratories, 183 were sent in by officers of the Department of Agriculture, and 100 were collected by officers of the Section while on safari. A further 44 advisory specimens were handled by the Plant Pathological Laboratory at the Plant Breeding Station, Njoro. These included the first record of *Puccinia hordei* on barley.

The following diseases were of particular importance:—

Sugar Cane.—Sugar Cane Smut (*Ustilago scitaminea*) was found in Kenya during 1958, although it now appears that its presence was first suspected in 1956. This disease is likely to be of some importance to the East African sugar industry. It has been seen in several localities in Nyanza and in one locality at the Coast. As it had undoubtedly been present in these areas for some appreciable time before the pathologists knew of it, all hope of complete eradication was soon abandoned. Some 6 per cent of Kenya cane comes under the category of "very susceptible" and it is likely that the varieties concerned (Co. 331, Co. 312, Co. 453, Co. 301, Co. 213) will have to be discarded. About 60 per cent of Kenya cane is "susceptible" (Co. 421, Co. 419, Co. 432, N.Co. 310, N.Co. 291) and considerable doubt exists concerning the effect of smut on these varieties. Full details of this new disease outbreak are being published seperately.

Rice.— A high proportion of sterile heads in the long rains rice crop at the Mwea/Tabere Irrigation Scheme resulted in severely reduced yields and this was one of the more difficult problems tackled during the year. Detailed investigations largely ruled out the possibility of factors such as fungal, bacterial or virus diseases, insect damage, nutritional factors, soil physical properties, deficiencies and toxicities, genetical factors, anthesis and pollination failures and various physiological disorders such as "Straightheads", etc. being responsible. It has been concluded tentatively

that the sterility was due to excessively cold irrigation water and, possibly, excessively cold air temperatures. The irrigation water is derived from melted snow and ice on Mount Kenya and, during the cold season, cold winds blow down from the mountain. Detailed water temperature records were not available but it was noted that maximum sterility occurred around the water inlets and it appeared that there was less sterility in the fields furthest from the canals. It seems that the water had time to warm up in the first field before going into the second and so on up to final drainage away from the fourth field. If this hypothesis proves correct, the solution to this problem is likely to be found in some system of warming the water in open fields before letting it on to the rice.

Potatoes.—Although not the most important disease in Kenya, Bacterial Wilt of potatoes (*Pseudomonas solanacearum*) is likely to be the most difficult plant pathological problem. When prices are favourable, 1 acre of potatoes yielding 10 tons is nearly as valuable as 1 acre of coffee and there are prospects of considerable increases in potato acreages. However, Bacterial Wilt, which has been established in Kenya for many years, constitutes a threat almost as serious as that of Wart Disease in Europe earlier in the century. The disease is largely confined to relatively small fields in African farming areas in Central Province and in horticultural plots around Nairobi. It is important both because there is no effective control method and because, in a wet season, it can virtually destroy a crop. It is dangerous in so far as potato tubers which appear healthy can carry the bacteria to new land if used as seed. As yet, there is no detailed information on the host ranges of the Kenya strains of *Pseudomonas solanacearum* and the degree of importance of this disease on alternative host crops such as tobacco, banana, castor and groundnuts is unknown.

Temperate Cereal Crops.—All leaf diseases of wheat and barley were abnormally severe during 1958. *Pyrenophora tritici-repentis* and *Septoria nodorum* which are normally considered of little importance caused damage to wheat crops and leaf diseases of barley were so severe that a special survey was undertaken. The assistance of Field Officers was enlisted and specimens of diseased barley were sent in from all the barley growing areas. *Helminthosporium sativum* (Spot Blotch), *H. teres* (Net Blotch) and *Rhynchosporium secalis* (Scald) were found to be responsible in roughly equal proportions. A tendency for *R. secalis* to predominate above altitudes of 8,000 ft. was noted and the complete absence of *H. gramineum* was observed. The latter has not been recorded in Kenya since 1936. All identifications were confirmed by the Commonwealth Mycological Institute. The total loss was difficult to estimate but is believed to be at least 40,000 bags of barley. While it was thought that weather conditions were largely responsible for the severity of these normally unimportant diseases, it is feared that the soil populations of the fungi are now so large that similar outbreaks are now more likely to occur. Rotation and the abandonment of the present, fairly widespread system of monoculture are believed to be of prime importance in the reduction of severity of these diseases.

The report of the Plant Pathologist at Njoro on wheat stem rust is included in the report of the Senior Plant Breeder.

Tropical Cereal Crops.—Head Smut of maize (*Sphacelotheca reiliana*) proved abnormally damaging in 1958. It had previously been considered a spectacular but relatively unimportant disease but this view is now being revised. White Blight (*Helminthosporium turcicum*) has been troublesome

in the maize breeders' plots at Kitale and Katumani. It may eventually be found to be the most damaging of all the Kenya maize diseases. The three smuts of Sorghum (Head Smut; *Sphacelotheca reiliana.* Loose Smut; *S. cruenta* and Covered Smut; *S. sorghi*) were also fairly damaging, Covered Smut being the most severe, particularly on the high quality, white sorghums such as Dobb's White. The relatively simple control methods for Covered Smut are suitable for widespread publicity in the drier African areas and could lead to worthwhile increases in yield.

Temperate Vegetable Crops.—Apart from a general increase in disease incidence during the abnormal long rains season, the plant pathological picture with respect to market garden vegetables remains as in previous years. Root Knot Eelworms (*Meloidogyne* spp.) continue to be a cause for concern. Ring Spot (*Mycosphaerella brassicicola*), first recorded during 1957, continued to do fairly severe damage to a Brussels Sprouts crop on the South Kinangop but a neighbouring cauliflower crop was only slightly affected. Degeneration of cauliflower curds was attributed to poor quality seed and the aid of the U.K. Ministry of Agriculture's Rosewarne Experimental Horticultural Station was enlisted in this connexion and is gratefully acknowledged. Downy Mildew of Onions (*Peronospora destructor*) was more prominent than usual and both Downy Mildew (*Pseudoperonospora cubensis*) and Powdery Mildew (*Erysiphe cichoracearum*) continue virtually to prohibit the cultivation of sweet melons and seriously hamper the cultivation of cucumbers. Karathane has been found to control *Erysiphe cichoracearum* successfully on cucumbers where all other fungicides have failed. *Alternaria dauci* was serious on a few carrot crops and *Septoria apii* was recorded several times on garden peas. *Sclerotinia sclerotiorum* was responsible for some fairly severe damage to lettuce crops. Rust (*Uromyces phaseolorum*) was so severe on the "Michigan Pea" variety of dwarf beans that their future cultivation is in jeopardy. Blight (*Phytophthora infestans*) and *Septoria lycopersici* were both severe on tomato crops, particularly during August. A field trial to test the effects of the systemic insecticide "Metasystox" on the tomato root knot eelworm (*Meloidgyne* sp.) was laid down but no results were available at the end of the year.

Tropical Vegetable Crops.—Wilt of Pigeon Pea (*Fusarium udum*) was serious in Southern Province. It is a difficult disease to control. *Synchytrium dolichi* was responsible for some losses in cowpea crops, also in Southern Province. Diseases of chillies (*Capsicum* spp.) continue to limit the value of this useful African cash crop.

Ornamentals.—A wide range of miscellaneous ornamental plants suffered from various diseases and reflected the general high disease incidence of 1958. Rust (*Uromyces gladioli*) and Botrytis Rot (*Botrytis gladiolorum*) of gladiolus and the various carnation leaf diseases were probably those of greatest economic significance.

Pasture Plants.—A species of *Cochliobolus* which may be new, has been causing considerable damage to Rhodes Grass (*Chloris gayana*) leys. There seem to be varietal differences in susceptibility. Bunt (*Tilletia echinosperma*) has again reduced yields of Nandi Setaria (*Setaria sphacelata*) in some areas The Scott Laboratories crop has remained free of this disease.

The following diseases were recorded for the first time during 1958:—

Pathogen	Host	C.M.I. No.
Ustilago scitaminea	*Saccharum officinarum*	73028
Peronospora viciae	*Pisum sativum*	
Puccinia pelargonii zonalis	*Pelargonium* sp.	73879
Curvularia trifolii	*Trifolium repens*	74459
Fusarium sp.	*Eleusine coracana*	
Pectobacterium carotovorum f. sp. *chrysanthemi*		
Puccinia penniseti	*Solanum melongena*	75315
Pseudoperonospora cubense	*Cucumis melo*	
Gloeocercospora sp.		
Periconia lateralis	*Panicum maximum*	72595
Periconia digitata		
Periconiella echinochloae		
Crytodidymosphaeria clandestina	*Panicum meyerianum*	72596
Mycosphaerella pinodes	*Pisum sativum*	72599
Cercospora sp.	*Delphinium*	72900
Septoria pisi	*Pisum sativum*	73294
Septoria geranii	*Pelargonium* sp.	73688
Colletotrichum circinans	*Allium cepa*	73882
Ascochyta sp.	*Sesamum angolense*	73883
Cercospora ternateae	*Clitoria ternatea*	74195
Colletotrichum truncatum	*Phaseolus lunatus*	74196
Leptosphaeria michotii	*Saccharum officinarum*	75313
Cercospora atromarginalis	*Solanum nigrum*	73081
Plasmopora halstedii	*Cineraria grandiflora*	72593
Septoria sp.	*Pelargonium* sp.	73686
Leveillula taurica	*Aquilegia*	72901
Colletotrichum capsici	*Coffea arabica*	73296
Curvularia sp.	*Coffea arabica*	73295
Ascochyta phaseolorum	*Phaseolus lunatus*	73687
Didymosphaeria panici	*Pennisetum purpureum*	73689
Cercospora canescens	*Vigna sinensis*	73690
Cercospora sorghi	*Pennisetum purpureum*	73691
Helminthosporium sp.	*Croton macrostachys*	73762
Septobasidium sp.	*Ceanothus*	73763
Ascochyta phaseolorum	*Phaseolus aureus*	73881
Ragnhildiana agerati	*Ageratum conzoides*	73764
Glomerella cingulata	*Lathyrus odoratus*	74194
Dendryphiella interseminata	*Passiflora edulis*	75307
? *Bacterium tumefaciens*	*Citrus limonia*	
? *Pseudomonas glycinea*	*Glycine max*	
? *Pseudomonas lacrymans*	*Cucumis sativus*	
? *Pseudomonas primulae*	*Primula* sp.	

(X) omitted at first - now listed as to its correct determination.

The following additional determinations were received from the Commonwealth Mycological Institute at Kew. The figures are the C.M.I. accession numbers:—

Fungus	Host	C.M.I. No.
Mycosphaerella sp.	*Oenanthe palustris*	72594
Oidium sp.	*Delphinium*	72899
? *Gliocladium roseum*	*Cytisus* sp.	73293
? *Phleospora*	*Acanthus mollis*	72902
Oidium mangiferae	*Mangifera indica*	73878
Pythium sp.	*Fuchsia*	73297
Aecidium hoffmannii	*Conyza newii*	73759
Phytophthora infestans	*Solanum incanum*	73760
Spongospora subterranea	*Solanum tuberosum*	73761
Oidium caricae	*Carica papaya*	73880
Tilletia echinosperma	*Setaria trinerva*	74461
,, ,,	*Setaria trinerva*	74462
,, ,,	*Setaria longiseta*	74463
,, ,,	*Setaria splendida*	74464
Cerebella andropogonis	*Setaria phleoides*	74465
Tilletia echinosperma	*Setaria trinerva*	74466
?	*Panicum maximum*	74467
Tilletia ayresii	*Panicum maximum*	74468
Helminthosporium tritici-repentis ..	*Triticum vulgare*	74469
Mycosphaerella musicola	*Musa* sp.	75311
Peronospora destructor	*Allium cepa*	75312
Phragmidium tuberculatum	*Rosa* sp.	75316
Rhynchosporium secalis	*Hordeum vulgare*	75222
Helminthosporium sativum	,, ,,	75223
,, *teres*	,, ,,	75224
Puccinia hordei	*Hordeum vulgare*	

Seed Testing

Two thousand eight hundred and six samples were submitted for testing during 1958. Of these, 677 were cereals, 842 were ornamentals, 362 were vegetables, 358 were Rhodes Grass (*Chloris gayana*), 118 were Setaria, 217 were other grasses and 221 were miscellaneous. Nearly every year during the past decade has seen an increase in the annual number of samples tested. The number of seed samples tested each year is still very small compared with other, more developed countries, however. It is expected that the publication of the new "Seeds Rules" in October 1957 will lead to greater annual numbers of samples.

As in previous years, the busy period of the year occurred during the first three months and over 1,100 samples had been tested by the end of March. During this period, it was necessary for most of the plant pathological and legume bacteriological staff to be seconded to the seed testing laboratory.

The old legume bacteriological laboratory became vacant in September and has been converted into a grass seed laboratory. This is considered to be part of a general trend whereby various sections of the work will be separated from the main laboratory as the numbers of samples begin to exceed its capacity.

Some concern was felt about the accumulation of sodium carbonate due to evaporation of Nairobi tap water from the filter papers used in germination tests. This tap water is fairly soft but, apparently, it contains an unusually high proportion of sodium carbonate. An experiment to compare the effects of demineralized water versusu tap water on germination of Rhodes grass seed was therefore carried out but no significant difference was found. There were 64 filter papers of 100 seeds for each type of water.

The publication of the Seed Rules 1957 in October of last year led to a certain reappraisal of the work of the seed testing laboratory. The main effects felt were a considerable increase in revenue earned and the issue of certificates for "Government Tested" and "Government Certified" seeds. The Seeds Ordinance is still too new, however, for the public to have made great use of it. The publication of the Seed Rules also affected potato work (see below).

Legume Bacteriology

Two hundred and eighty one orders for legume inoculant were received during the year. These involved a total of 1,201 units sufficient for nearly 32,000 lb. of seed. The demand for inoculant of the various legume species was as follows:—

Legume	Units of inoculant despatched	Pounds of seed for which sufficient
T. semipilosum	304	6,080
Lucerne and *Medicago* spp. ..	823	5,660
Soya and *G. javanica*	283	11,320
Other indigenous clovers ..	72	1,440
Lupins and Serradella	58	2,320
Peas, lentils and vetches ..	56	2,240
Temperate clovers	52	1,040
Miscellaneous spp.	93	1,860

Five hundred and forty-two units were prepared for Government stations, principally those belonging to the Department of Agriculture, and 641 units were prepared for members of the public. While it is known that appreciable quantities of imported, proprietary brands of inoculant are now being used in Kenya, this ratio implies that the potential public demand for inoculant is likely to be considerably greater than the present, actual demand. A powerful trend can be noted in the sale of inoculant; only two years ago, when commercial brands of inoculant were not readily available, 40 per cent of the production at Scott Laboratories was for lupins. Last year this figure was 36 per cent and this year it is only 3 per cent. The demand for inoculant for indigenous clovers which is not available commercially, has increased as the demand for lupins has decreased and indigenous clovers accounted for 31 per cent of the 1958 demand compared with only nine per cent of the 1956 demand. The total demand for Scott Labs inoculant remains fairly constant at about 300 orders per year. As in previous years, a few cultures were sent abroad, mainly to other countries in Africa.

Continued, acute staff shortages have again restricted experimental and research work. However, considerable progress was made in September when this work was transferred to another building with considerably increased laboratory space and facilities. By the end of the year, the effects of new or

greatly improved testing facilities, deep-freeze storage, bacterial counting facilities, ultra-violet sterilization, etc., were already being felt. The year closed with the routine testing of the 30 *Rhizobium* strains in current use. These tests will all be completed in time for the main long rains growing season.

Potato Work

The publication of the Seeds Rules late in 1957 signalled the start of a new scheme of potato seed certification with respect to freedom from disease, trueness of variety, size and dressing. This is coupled with the appointment, early in 1958 of an Assistant Agricultural Officer (Potatoes) to the Plant Pathological Section and a general intensificaion of the work.

The importation, testing, multiplication and maintenance of new varieties of potatoes continued. This work is now being intensified and much of the field work is being transferred to Ol Joro Orok where land is less restricted than at Scott Laboratories. Although many well-known varieties are being imported, the emphasis of the importations was still placed on blight (*Phytophthora infestans*)-resistant potatoes.

Publications

Guthrie, E. J. & Robinson, R. A.—Barley leaf diseases. *The Kenya Farmer*, December, 1958, p. 21.

R. A. ROBINSON,
Acting Senior Plant Pathologist.

ANNUAL REPORT OF THE SENIOR SOIL CHEMIST, 1958

Soil Survey

(Dr. J. Thorp, Mr. G. A. Woodruff, Mr. F. T. Miller)

As the arrival of Dr. Mehlich in 1957 was a landmark in soil chemistry in Kenya, so was the arrival (in February, 1958, for a stay of 18 months, also under I.C.A.) of the eminent American Soil Classification Specialist, Dr. James Thorp a landmark in local soil survey and classification. He was followed within the month by two experienced field workers on soil survey: Messrs. G. A. Woodruff and F. T. Miller. These men founded Kenya's first soil survey team and they initiated the first soil survey yet attempted in the country having as its direct objective the intensification of land usage.

The areas designated for the initial soil survey projects were areas each of about 130,000 acres. One of these known as the Songhor survey cover parts of Kericho and Central Nyanza at the eastern end of the Kano Plains and on the contiguous rising land to the east, north and south. To the west it joins with the Sir Alexander Gibb and Partners survey of the Kano Plains. The other survey known as the East Koinyango Survey, is centred on a point about 20 miles north-west of Kisii Township and is located mainly in the East Koinyango location of South Nyanza. Both surveys are in connexion with projects to build a white sugar factory and to develop sugar cane products to serve it.

All the field and much of the laboratory work in connexion with the Songhor survey was completed during 1958 and a report is in an advanced state of preparation. About 30,000 acres of the East Koinyango survey had been covered in the field by the end of the year.

Several thousand acres of part of the Songhor survey already has been under sugar cane for a number of years and the experience of producers supplemented by observations on the main plantings of the crop and small trial plantings which were found scattered through the rest of the area proved most valuable in assessing production potential over the survey area as a whole. Scattered plots of established cane also exist in the East Koinyango survey and the yield data from those which have been collected during harvests to supply the local jaggery factory are now being examined with similar intent.

The surveys are being made by traversing at intervals of one-quarter to three-quarters of a mile, using ground indications and soil indications apparent on available aerial photographs of the area to guide the actual location of the traverses. Soil profiles were examined horizon by horizon by taking auger borings (or where considered necessary by digging pits) at points similarly located along the traverses, for texture, structure, parent material, colour, drainage and other morphological characteristics, and described. On the basis of these profile descriptions and on slope and erodibility, the soils were classified into series, types and phases, the separate series being named usually after the place near which the series was first described. The basis of classification was kept fluid and where necessary sites already surveyed were revisited later in the survey and the classification reviewed and modified as necessary in the light of the increasing local knowledge acquired during the survey.

Typical profiles of each of the main soils recognized were collected and submitted for laboratory examination, samples being taken to bedrock or down to some 12 ft. where the soils were very deep. Additional surface samples from typical sites in ten of the most important soils were taken for examination by the Webb/Hewitt pot tests.

The surveys are being made by traversing at intervals of one-quarter to up on the aerial photographs and the boundary of each soil unit once established was drawn in. Fortunately, the findings of the laboratory analyses proved sufficiently in line with field observations for little subsequent revision of the field classification and mapped boundaries to be necessary. Mr. Roche, the I.C.A. photogrammetrist, using equipment belonging to the Survey of Kenya, kindly projected for us the aerial photographs with soil boundaries shown, on to the standard 1/50,000 Kenya Survey maps covering the Kano Survey area and transferred the soil boundaries to these maps. Checking, correction, designation of the soils in each separate soil area on the map and computation of acreages followed and finally there was the preparation of a map showing the suitability of the various parts of the survey area for sugar production. This suitability map was prepared by considering in detail each soil mapped and by estimating its production potential using as a basis the known potential of the soils already locally under sugar. Four suitability classes: "very suitable", "suitable", "usable" and "unsuitable" were established and, on the suitability map, the areas so found were outlined as land units. Copies of this map with a short supporting memorandum have been made available to interested farmers and sugar manufacturers and rapid developments have followed its distribution, towards the acquisition of a factory and extension of local sugar cane production. Similar maps dealing with the grouping of the individual soils according to other characteristics are under consideration.

The detail to which mapping was possible and the intervals between traverses and inspection points along traverses were determined by the scale of the base maps used and the details discernible in the photographs. Accordingly, where the soils were found to change rapidly over short distances (and this was the case particularly where recent stream cutting had taken place) it proved necessary to map the situation as a soil complex. Likewise where areas of one soil which were too small to map occurred within a larger mappable soil unit, the existence of the small areas had been noted by special comment in the report. Again, in a number of instances it proved necessary to allow a fairly wide range of characteristics for a given soil to be made mappable. The Surveyors had to make do with existing Survey of Kenya aerial photographs for the Songhor survey but were able to have the East Koinyango area specially flown. The East Kinyango photographs were taken with special infra red sensitive equipment and this gave a most useful additional clarity to the photographs so far as soil recognition was concerned. Again, the pictures being new, they gave an up-to-date record of local landmarks which made it comparatively easy for the Surveyors to locate themselves even when dealing with the transient pattern of local shifting cultivation.

The area covered by the Songhor survey was found to comprise a broad plain, continuous with the great Kano Plain, but rising eastward and merging with alluvial fans and valley terraces of the hills and mountains to the north, east and south. The nearly level Kano Plain is tributary to the Kavirondo Gulf of Lake Victoria and is believed to have been covered by the lake during the high-water stages that prevailed during the "Pluvial" (rainy) periods of Pleistocene time. Much of the soil material of the plain was deposited in this old arm of the lake by streams that brought erosion products from the surrounding mountains. The lowest level in the area, on the Nyando River south of Kibigori, is about 3,860 feet above sea level and about 135 feet above Lake Victoria. The highest land is near the top of the Nandi escarpment north of Kibigori, and on the west edge of the Tinderet Highlands, south-east of Songhor, where elevations are somewhat more than 6,000 feet. Gradients of 1,000 to 1,500 feet to the mile are common on the Nandi escarpment.

The broad central plain is bordered on the north by the spectacular wall of the Nandi escarpment and on the east by the Tinderet Highlands. South of the Nyando River a lower rocky tableland extends from just west of Muhoroni to the Awasi Market, on the Kisumu Road, about 2½ miles from the western border of the area. The tableland is a lava bed that lies about 4,500 feet above sea level and 100 to 300 feet above the plain. From Kibigori the central plain merges northward into a series of alluvial fans that come down from the Nandi escarpment. Eastwards and north-eastward the plain rises gradually to an elevation of 4,500 feet where it divides and fingers its way up the many stream valleys of the Tinderet Highlands.

On the south-eastern part of the broad central plain the soil materials comprise beds of water-laid heavy clay, up to nearly 100 feet thick, interbedded with several layers of light-coloured laminated volcanic ash of fine sandy and silty textures, and many lenses of gravel, sand and cobble that mark the courses of former streams that entered the ancient lake from the north and east. Alluvial-fan deposits of mixed, moderately sandy and clayey textures come down from the Nandi escarpment, and their terraced surfaces blend gradually into the level Kano Plain. The clay beds seem to have been deposited partly in marshes and partly in an open lake, and some of them appear to have been subjected to soil-forming processes before later deposits were made. For example, about 1¾ miles south-southwest of Volo sisal factory a dark-brown clay soil with subsoil containing abundant calcium carbonate concretion is overlain in turn by a few feet of laminated volcanic ash, and the modern (present) soil at the surface—all in an area that has been exposed by recent dissection of the lake plain by the Ainomotua River. The base of the volcanic ash contains many prints of the leaves of water-loving herbaceous plants.

The higher of the alluvial-fan deposits around Volo and Chemelil sisal estates, and along Kundos (Kapchure) River 6½ miles north-east of Kibigori, overlie at least part of the clay-ash beds of the "lake plain" and are, therefore, younger in age. Whether they are younger than *all* of the volcanic ash is not yet known. These higher alluvial-fan deposits are strongly weathered and the soils are of kinds that we would expect to require many thousands of years for their formation.

The lake-clay and ash beds extend up the Mbogo River in an ever-narrowing strip nearly to Songhor, where at an elevation of about 4,600 feet they merge with river sediments. They were traced up the Ainomotua Valley to about 1¾ miles east of Volo sisal factory to an elevation of about 4,300 feet; and up the Makindu and Nyando Rivers to about 4,500 feet—almost to Muhoroni. Similar beds from near Songhor up Mteitei Valley to a point about 3½ miles east-north-east of Mbereri estate headquarters may have been deposited in a basin separate from the Kano Plain arm of Lake Victoria. These beds are about 75 feet thick and have not yet been demonstrated to connect with the other lake beds. If all of these deposits were in fact laid in an arm of Lake Victoria, it is evident that they have been lifted relatively by crustal movements above their original level at the eastern edge of the Songhor area.

The rivers that cross the central plain have cut channels in the clay beds and underlying formations to measured depths of as much as 96 feet in Mbogo Valley south-west of Songhor, and possibly deeper in other places, and as much as two-thirds of a mile wide near the confluence of Mbogo and Ainomotua rivers. Some of the valley slopes thus formed are smooth enough to cultivate. Others are as rough and broken and almost as bare as the Badlands of western United States. The valleys were cut in the clay plains in several stages as shown

by strath remnants at two or three different levels below the plain, and a series of alluvial-terrace remnants just above the level of frequent overflow. All these features have a bearing on soils and land use in the Songhor area.

The Mbogo and Ainomotua River valleys are separated by high almost precipitous mountains of gneiss; and similar mountains separate the Nyangoro and Ainomotua headwaters. The gneiss, the same as that of the Nandi escarpment, contains thin veins of white quartz and pegmatite. Soils on these mountains are very thin and stony. Hilly areas of more deeply weathered gneiss lie west and south of Muhoroni.

The foothills and mountains along the eastern border of the area comprise a complex of volcanic tuffs, basalts, phonolites and agglomerates which are products of the successive eruptions which took place some millions of years ago in the Tinderet Highlands. The whole region, formerly much smoother than now, has been cut into rugged forms by the various rivers.

The harder rocks form promontories and cliffs, and softer rocks have been eroded to less precipitous slopes. The oldest of these volcanic deposits is a gritty, whitish to pale yellow tuff with many included small and large broken fragments of granitic gneiss. In many places this tuff has thin veins and spots of secondary calcium carbonate, and it appears to merge with the Koru limestone about three miles east-south-east of Muhoroni. It merges similarly with tuffaceous limestone on Ngeron estate near the foot of the Nandi escarpment.

This tuff, stated by Binge (personal communication) to be of Miocene age, is the parent rock of thousands of acres of dark-grey and black clay soils along the eastern border of the area where it was eroded into long smooth slopes before the soils were formed on it. The formation and the rocks overlying it are tilted upward from west to east. It appears in a deep valley trench near Volo at an elevation of less than 4,000 feet and in the Mbogo Valley, on the eastern edge of the area, where it is covered by other rocks, at about 5,000 feet. It is an important soil-forming rock from near Muhoroni northward to the Nandi escarpment.

Around the rim of the lake plain are many patches of land that seem to represent a former undulating plain which, since its formation, has been more or less dissected by streams. The soils on these old plain remnants have subsoil layers of vesicular and concretionary ironstone (laterite or murrum) that probably formed under a fluctuating high water table, which still persists in some areas. Some of the laterite is formed from gneiss, some from basalts and phonolites. Patches occur at the following places and elevations:—

(1) West and north-west of Chemelil Sisal Estate Headquarters—4,000 to 4,500 feet.

(2) Two, and 3½ miles south-west of Songhor P.O.—4,800 to 5,000 feet.

(3) Three miles south-east of Muhoroni—about 4,700 feet.

(4) Five miles south-west of Muhoroni on Kericho Road—about 5,300 feet.

The entire Songhor survey area is drained by the Nyando River and its tributaries. Most of the streams on the lake plains, even those that are deeply entrenched, have meandering courses which suggest that they have been rejuvenated in recent geologic times. The winding streams have cut through the soft clay and ash beds of the lake plains and have superposed themselves on older underlying and harder formations.

The water now flows rather quietly along stretches where the streams are running in clay beds, but more swiftly over the harder beds. For instance, the Ainomotua above Volo sisal factory has a series of rapids and cascades, where the stream has cut through the soft clays and tuffs and has struck buried ridges of hard gneiss and dikes of black porphyry. One such place is at the twin bridges at the confluence of Ainomotua and Ainopsiwa rivers. The streams that come down from the Nandi Escarpment and Tinderet Highlands are swift and fairly straight until their speed is checked in the foothills by the sudden decrease in gradient. Here they tend to drop their sediments and many of them have built up beds of alluvium in which some of the streams have spread out and disappeared. In some of these semi-swampy areas new streams are formed at lower ends by seepage.

Drainage is very sluggish on the nearly level interfluves of the lake plain, and much of the level land must have surface drains before optimum crop response can be expected. Curiously enough, farmers experience considerable trouble with waterlogging during the rainy season on some of the sloping black and grey clay soils along the Muhoroni-Songhor road where slope gradients range up to as much as 6 per cent. Rapid run-off from some of the alluvial fans in the area has produced severe erosion, both where the soils have been over-grazed, as in the African Reserves, and where water has been concentrated in road ditches and diverted to adjacent sloping land. The lower margins of long gentle slopes in the Songhor area are almost universally waterlogged by the end of the rainy season.

The laboratory and greenhouse examination of the Songhor survey samples disclosed widespread nitrogen phosphorus and sulphur deficiencies but only sporadic instances of other deficiencies. The soils were found to fall into four distinct groups on the basis of their dilute acid extractable phosphorus content.

Where this was high in the surface and high or medium in the subsoil the soils turned out to be those which the Field Surveyors had described as "very suitable" for sugar cane growing. The main nutrient need of this group of soils appears to be for nitrogen, though potash attains a satisfactory level in the surface only in a number of instances and prolonged intensive cultivation is expected to lead to a declining status of the nutrient. The sulphur status is variable but seldom very low.

Where a low or medium phosphate content in the topsoil and a low content in the subsoil was counteracted by a high content below 3-5 feet, the soils generally were those which the Surveyors had classified as "suitable" for sugar cane production. The profile of each member of this group of soils was found to contain volcanic ash or tuff and independent evidence was collected that these parent materials give rise to the high phosphate availability in the deep subsoil. The main need again is for nitrogen though in numerous instances the need for sulphur is equally great.

The group in which the phosphate status was low to medium in the surface and low throughout the sub-surface horizons corresponds with the group of soils which the Surveyors had classed as "usable" for sugar cane production. Nearly all these soils proved markedly deficient in nitrogen.

The clay mineral composition indications agreed well with field classification, 2:1 type expanding lattice clays being dominant in most of the soils. Again the solonetzic character of a number of the soils mapped was reflected in high laboratory sodium figures.

A minor soil survey was undertaken near Hola on the basis of which approximately 1,000 acres of land were found which by local standards are considered suitable for development under irrigation. The areas within this which topographic factors make suitable for irrigation later were determined and of these 400 are being laid out for irrigation for cropping in 1959.

Additionally Dr. Thorp travelled widely in connexion with his development of a soil classification framework for Kenya. He recognized the existence of most great soil groups in the country and was able to match most of the soils he saw with soils which he has seen elsewhere in the world, but found many of them in combinations which were new to his experience.

Soil Test Methods

(Dr. A. Mehlich)

In preparation for the soil survey and in continuation of the development of a soils analysis service for the farming public, the available nutrient assessment procedures developed by Dr. Mehlich and tested against conventional procedures here in 1957 were adopted for routine soils analyses and the laboratory so organized and equipped for the mass handling of samples that available nutrient determinations on 70 samples per day can be sustained. Under these procedures, available phosphorus, potash, magnesium, calcium, manganese and sodium are determined by extracting 5 ml. of soil finer than 2 mm. with 25 ml. of an aqueous 0.1N HCl/0.025N H2S04 solution by shaking for one minute, standing for one hour and then mechanically shaking for a further ten minutes. After filtering, aliquots are taken for the colorimetric determination of phosphorus, magnesium, and manganese and the flame photometric determination of sodium potassium and calcium. For phosphorus, the molybdo-vanadate method is used. For magnesium, thiazol yellow or titan yellow specially for magnesium determination is used as the dye and this is stabilized with a "Krilium" polymer as published in the *Jour. Assoc. Official Agric. Chemistry, 39* (1956), 518-523. Manganese is determined by the periodate method in the presence of phosphoric acid made alkaline with sodium hydroxide, thus eliminating the need for heat (*Soil Sci. Soc. Amer. Proc., 21* (1957), 625-628). Interfering anions (notably phosphate and sulphate) are removed from the 2ml. aliquot taken for flame photometry by diluting with 15 ml. water and shaking for 30 minutes with 0.5 ml. of the anion exchange resin "deacidite E", standing overnight and decanting. The procedures and the equipment used have been designed for rapid handling of the samples and with a view to simplicity and accuracy in calculation.

pH is determined on a 1/1 soil/water paste using a glass electrode. Organic carbon currently is determined by the Walkley Black procedure but a method developed by Barkoff (*Jour. Sci. Agric. Soc. Finland, 26* (1954), 198-210), is being investigated in which a recovery of about 95 per cent is possible and which holds considerable promise for mass handling.

The soil analysis routine is completed with a biological test for phosphorus nitrogen, sulphur and the possibility of trace element deficiency, using the fungus *Cunninghamella blakesleeana* (*Soil Sci. Soc. Amer. Proc. 2* (1938), 279-288). For the test as now operated, a powder containing all the nutrients required by the fungus for optimum growth is first prepared: this is designated as "plus all". Parallel powders are then prepared from which in turn the nutrients under test are omitted. Each powder is mixed with a separate sample of the soil, the mixture is brought to field moisture capacity with distilled water and it is then filled into plastic cups, 20 mm. diameter and 4 mm. deep. These are placed in perforations in sponge rubber pads which have been previously saturated with

water and placed in plastic boxes measuring 8 inches square and 2½ inches deep. To a test tube culture of the fungus are then added 3 ml. of water, a spore suspension is prepared and decanted into a petrie dish and from this one loopful of suspension is placed in the middle of a large soil plaque, an inoculation loop 3 mm. diameter being used for the purpose. The boxes are then closed with well-fitting lids and are incubated at 30 ± 1° C. for 48 hours. The diameters of the fungus growths are then measured with calipers, the growth of each of the cultures from which nutrients were withheld being expressed as a percentage of the growth of the "plus all" nutrient culture. The test is run in duplicate and where a trace element deficiency is discerned it is repeated with each of the trace elements withheld in turn, with the object of ascertaining the particular deficient trace element nutrient.

Apart from confirming the widespread existence of phosphorus shortage already established by farming experience field trial and earlier soil extraction procedures, the Mehlich analyses have shown many Kenya soils to have a low available nitrogen status and this is reopening the question of the desirability or otherwise of nitrogenous manuring (at least where the nitrogen availability indications are lowest) even small grained cereals, this despite the lack of success which has been the past general experience. Again indications are being obtained of unexpectedly wide instances of low sulphur status, particularly on grumosols, planosols and glei soils. The sulphur status of Kenya soils has been demonstrated already by the Pasture Research Team to be of great importance in determining successful pasture legume culture, so the sulphur test indications are proving of value in extending our knowledge of areas in which gypsum by virtue of its sulphur content should be tried for pasture improvement. The low sulphur content of some of the heavy sugar soils of the Kano Plains may well explain at least part of the great benefits which had been observed to accrue from gypsum applied to them with the intention of abating soil alkalinity and improving structure. Quite widespread occurrences of a rather low Mg/K ratio are being brought to light though these have not yet been correlated fully with the magnesium deficiency symptoms which have been discerned in Kenya on a number of susceptible crops. Areas where intense acidity prevails and in which investigation of liming will be of particular value are becoming increasingly well defined.

In particular as already described in the soil survey section the Songhor survey soils have been classified on the basis of phosphate status into groups which accord well with the Field Surveyors' appraisals. Additionally valuable leads have been given on the sulphur, nitrogen, boron and zinc status of the Songhor soils in preparation for the laying down of soil fertility experiments on the basis of the survey.

Following his recognition in 1957 of the need to supplement his nutrient availability determination procedures with a more fundamental investigation on local soils of the nature of the colloid constituents and their electro-chemical properties, Dr. Mehlich developed modifications of the characterization procedures published in *Jour. Assoc. Official Agric. Chem., 36* (1953), 445-457, which make possible the classification of the organic and mineral colloid components of soil according to their charge carrying characteristics:—

(1) Permanent negative charge components: these are components whose charges are not affected by soil pH.

(2) Uncountered negative charge components: these include organic matter, montmorillonite and other 2:1 lattice clays.

(3) Counter-balanced charge components: these include kaolinite and other 1:1 lattice clays, probably together with certain amorphous exchange materials.

(4) Uncountered positive charge components: these include the sesquioxide hydrates.

The percentages of each component are rounded to the nearest unit of 10 for recording the colloid class. The colloid class distribution of three soil profiles from the Songhor survey are presented:—

Depth	Songhor Silt Loam	Colloid Class Martin Clay Loam	Kunds Clay
0 inches			
	4–7 : 1 : 2	4–7 : 0 : 3	5–0 : 8 : 2
8 inches			
	5–4 : 5 : 1	5–4 : 6 : 0	—
10 inches			
	—	—	5–0 : 8 : 2
14 inches			
	6–5 : 3 : 2	4–4 : 6 : 0	—
19 inches			
	—	—	5–0 : 8 : 2
22 inches			
	7–7 : 1 : 2	—	—
28 inches			
	—	—	6–0 : 8 : 2
31 inches			
	—	5–5 : 2 : 3	—
39 inches			
	7–7 : 0 : 3	—	—
42 inches			
		5–4 : 3 : 3	—
45 inches			
	7–8 : 0 : 2	—	—
56 inches			
	—	—	6–0 : 8 : 2
72 inches			
	—	6–4 : 3 : 3	—
73 inches			
	8–8 : 0 : 2	—	—
91 inches			
	—		7–1 : 8 : 1
96 inches	end	—	
100 inches			
	—	8–3 : 6 : 2	—
108 inches			
		—	8–2 : 7 : 1
115 inches		end	
120 inches			end

The four figures used to designate the colloid classes: e.g. 4–7:1:2, indicate the following approximate percentage charge distributions: 4 = 40 per cent permanent charge, 7 = 70 per cent uncountered negative charge, 1 = 10 per cent counter balance charge and 2 = 20 per cent uncountered positive charge. The kinds of colloid present thus are approximately 70 per cent organic and/or

2:1 lattice, 10 per cent 1:1 lattice silicate materials and 20 per cent sesquioxide hydrates. It is seen that the Songhor soil colloid classes are dominately uncountered negative charges— i.e. 2:1 lattice clays—particularly below a depth of 22 inches. In contrast Kundos clay contains permanently counter-balanced charges—i.e. sesquioxide hydroxide and is very uniform throughout the profile. The Martin clay loam is intermediate and varies with depth. This type of information has already shown itself of considerable value in aiding the Field Surveyors in their classification of the Songhor survey soils.

The results of the colloid characterization determinations have also proved useful in the rational interpretation of the date obtained in the nutrient determination procedures and in field fertilizer trials. Thus whenever the residual effect of phosphate upon a subsequent crop in a field trial is significant, the colloid characterization indicated even on red loams an excess negative charge of up to 40 per cent; the implication here is that the high phosphate fixing anion charge of the sesquioxide hydroxide is countered in some way by the negative cation exchange surface and that where this becomes an important component, appreciable amounts of added phosphate are held by the soil in forms available to plants.

The permanent charge is a measure of the extent to which hydrogen on the soil colloid is highly dissociated: consequently a soil saturated with bases to the capacity of the permanent charge would appear to be at the critical level at which nutrients can move freely into the root zone and become available for plants. Accordingly the degree to which the base saturation of a soil falls short of this capacity is considered by Dr. Mehlich to be a measure of its lime requirement. The concept is now being tested on the basis of existing lime trials and of new trials incorporating lime applications based on permanent charge status measurements.

Bioassay

This continued, using the tomato and in one case Trifolium rupellianum as indicator. The latter named proved too slow growing and insufficiently sensitive to deficiencies already known to exist in the soil tested. In the first instance the 1957 layout was continued but latterly the manganese copper zinc and molybdenum tests were combined in one "minus trace" treatment and the number of controls increased: only if there was a statistically significant reduction in yield in the "minus trace" treatment were these nutrients investigated individually. In addition to the soil tests, a set of treatments was applied to plants rooted in acid treated glass wool to test the technique employed. Foliar symptoms and reductions in growth were obtained for all the nutrients covered by the test except molybdenum and zinc. When molybdenum was withheld a reduction in growth was obtained without the development of foliar symptoms: in the supposed absence of zinc, the crop grew perfectly well.

An improvement in the precision of the Webb/Hewitt tests was obtained by starting the treatments at a very early stage of growth. By so doing the check which some of the plants seemed to receive particularly on soils which are severely deficient in phosphate was minimized and this seemed to more than compensate for the loss in precision which might be expected from discontinuing the earlier practice of delaying applying the treatments until the plants could first be selected for apparent uniformity.

The 1958 samples were tested partly in connexion with specific field problems and investigations, partly to provide some Field Officers with basic information on important soils in their district and partly to supplement the fertility characterization studies associated with the soil surveys.

The most serious and widespread deficiency again was phosphorus, only three samples failing to give statistically significant increases in yield where this was applied. After phosphorus, nitrogen was the element for which deficiencies were recorded most often, these being most marked in soils from Trans Nzoia and Nyanza. There were numerous instances of sulphur deficiency, usually in conjunction with nitrogen deficiency. All the samples tested from the Trans Nzoia and Nyanza were deficient and several from elsewhere in Rift Valley were slightly deficient. No instances of potassium or magnesium deficiency were recorded but there was a number of scattered slight calcium deficiencies. Copper deficiency was found in three samples from the Rift Valley floor and one from Ol Joro Orok; this represents some extension of the copper deficient area recognized by farmers in the Nakuru vicinity. In all cases (but also in some cases where no growth depression was recorded from withholding copper) the estimates for the element by Aspergillus were very low. Only two slight zinc deficiencies were noted but estimates by Aspergillus showed that the nutrient was in deficient supply in several areas; notably Trans Nzoia, Nyanza and Ol Joro Orok. One case of molybdenum was recorded—at Wanjohi, this being of note as there were simlar findings in neighbouring areas (South Kinangop and Ol Joro Orok) in 1957. Two instances of slight boron deficiency were observed in the Songhor survey samples.

The extent to which the pot test and laboratory indications correlated were investigated. The correlation coefficient between the pot test growth indication without phosphorus and the Mehlich chemically determined phosphorus was 0.78 while the correlation of the pot test with the Cunninghamella determined phosphorus was 0.62. The correlation between pot test and Cunninghamella nitrogen was 0.92 though 50 per cent or more of maximum growth by the Cunninghamella test appears to indicate a sufficiency of nitrogen for the tomato. The correlation coefficient for pot test and Cunninghamella sulphur was 0.91. Samples of the soils examined in 1957 were analyzed spectrographically at E.A.A.F.R.O. for molybdenum and zinc using a variety of extractants. In no case did the spectrographic analysis indications correspond with the pot test findings but the analysis for zinc extracted with 0.5N acetic acid accorded well with the Aspergillus estimates.

Direct field verification of the 1957 deficiency findings was attempted by general agronomy investigation officers at a number of sites, using factorial trials designed by us on the basis of the pot test indications. These proved singularly unsuccessful in reproducing deficiencies other than those already recognized locally in the field even though such deficiencies had been detected in the Webb/Hewitt pots. In particular, the soils of two citrus orchards near Machakos had been shown by Aspergillus and by spectrographic analysis, but not by pot test, to have a distinct zinc deficiency. Furthermore, chlorotic and rosetted leaves from these orchards also had a distinctly lower zinc status than healthy leaves. Even so neither the field situation nor the zinc content of the symptom bearing leaves was improved by massive injection of zinc compounds following the Roach (Technical Communication No. 16 Commonwealth Horticultural Bureau) procedures. The spectrographic analyses and an analysis of the water used for irrigating this orchard, however points to the possibility that the situation here is complicated by some boron toxicity.

The pot tests revealed no striking nutrient abnormality associated with the abnormalities in wheat quality which had been noted by the millers in the grain samples they had received from a number of farms during the course of their routine 1957 analyses.

Fertilizer Trials

(Mr. E. Boswinkle)

The survey, laboratory and greenhouse attack on soil fertility was matched with the continuation of field fertilizer trials. The results of the 1957 trials in African areas were analyzed and a programme of similar magnitude was undertaken in the field in 1958.

In Central Province the good progress over past years enabled the shifting of emphasis from experiments towards rates investigations and a wide scatter of 33 trials were laid down during the year. In preparing for these trials, patient enquiry was made into the rotation considered appropriate to each area by responsible field officers and a crop sequence based on their views was adopted for them. This was:—

	Long Rains	*Short Rains*
First year ..	Potatoes, fertilized.	Beans.
Second year ..	Maize residual.	Potatoes, some fertilized.
Third year ..	Maize residual.	Beans.
Fourth year ..	Maize undersown, some fertilized.	Grass.

In southern and in the northern part of Nyanza Province, special attention has been directed to extensive areas of soils which are derived from granites and ancient sediments. On these soils our earlier experience was that the response pattern seemed closely related to soil colour but more investigation was necessary to determine the significant colour feature and to relate it to fertilizer effect. Only a low density of trials is possible in Rift Valley Provinces and in Coast Province (where a start has now been made) so progress in those provinces once more remains slow.

The 61 Central Province 1957 long rains trials mainly were on potatoes: 31 measured residual effects of P and M and on these nitrogen and potash only were reapplied. The majority of the trials were in the Kikuyu and Star grass vegetation zones on deep uniform red or reddish brown loams derived from volcanic rock. The yields obtained in 1957 from the main crops of maize and potato trials are:—

Treatment	Potatoes—Bags per Acre						Maize lb. per Acre	
	Bracken		Kikuyu Grass		Star Grass			
	+	—	+	—	+	—	+	—
P direct	—	—	24·1	20·1	34·1	27·3	2,384	2,384
Residual	20·1	16·2	22·5	22·5	—	—	2,145	1,999
Manure direct ..	—	—	24·7	19·5	36·1	25·2	2,564	2,213
Residual	—	—	23·4	21·5	—	—	2,172	1,972
Lime residual ..	20·5	16·4	—	—	—	—	—	—
N direct	18·4	18·5	22·7	21·8	33·2	28·2	2,326	2,170
K direct	19·4	17·5	21·6	23·0	33·8	27·6	2,241	2,255

+ with, — without.

Higher than average rainfall brought on a blight incidence which adversely affected yields and responses in the potato trials and reduced their precision. Even so fairly substantial increases again resulted from the direct application

of 2-3 cwt. double supers or 15 tons FYM though the residual effects from the application of these treatments to previous crops were distinctly less. Benefits from N and K application occurred sporadically, the instances involving K often being associated with a distinct lessening of blight where this nutrient had been applied: the conditions under which K application can help alleviate blight damage however remain to be established.

The extent to which the responses measured in field fertilizer trials can be related to laboratory determined nutrient status indications was examined on the basis of the accumulated results of the 1956-58 potato trials, sufficient data now being available from them for a preliminary assessment of the situation. The Central Province potato trial responses to 2 cwt. per acre double supers in fact have correlated well with the laboratory indications for phosphate status. The relationships could be expressed by 0.1 per cent significance ($r=0.80$): — $y = 63.4 + 19.3 \log x$, where y is the "no phosphate" yield expressed as a percentage of the yield from the 2 cwt. per acre application of double supers and x is the phosphorus content of the soil in parts per million as measured by the Mehlich chemical procedures.

Average maize yields were more satisfactory but the responses to phosphate and FYM (0 and 15.8 per cent for direct application: 7.3 and 10.1 per cent for residuals, respectively) were distinctly less than the previous year. Responses to nitrogen again were variable but the number of trials was insufficient for the determination of the response determining factor. Overall the potash treatments had no effect.

The Central Province short rains trials mainly were on beans, the residual effect of fertilizer application to previous crops being measured. The mean yields obtained in lb. per acre are: —

Treatment	Bracken Zone		Kikuyu Grass		Star Grass	
	+	−	+	−	+	−
P	849	621	578	515	1,312	1,201
Manure	1,204	890	590	503	1,279	1,232
Lime	686	485	—	—	—	—

+ with, − without.

Once more residual responses persisted to the beans crop though these were distinctly stronger in the bracken zone than in the Kikuyu or Star grass zones.

Other trials concerned the fertilizing of bullrush millet (which showed responses to phosphate and manure residuals in the Star grass zone and to phosphate manure and liming on an acid soil in the bracken zone), fodder beets (which showed a variable response to nitrogen potash and manure in a fertile area of the Kikuyu grass zone), oats and wheat. In the bracken zone, where acidities run high (and this is the case over extensive areas) it was found that crop germination and establishment are impaired or may even be inhibited in the absence of liming.

In Nyanza Province all 28 trials successfully completed in 1957 were in the long rains and nearly all of these were on maize. Meaned results are, in lb. per acre:—

Treatment	+ Present	− Absent
P direct	2,996	2,875
Residual	2,035	1,680
Manure direct	3,070	2,794
Residual	1,883	1,832
N direct	2,873	2,723
K direct	2,816	2,780

Useful responses to phosphate residuals and to direct application of FYM were recorded. The lower overall responses to direct phosphate application to the recorded crop was due in part to the increasing attention being paid to soils on which the phosphate response pattern is less clear than the deep red or reddish brown volcanic loams and in part to our practice of measuring residuals only on sites where the direct effects were significant. On the latter, phosphate responding soils, the residual effects of phosphate application to previous crops remains strong.

It now seems that the niitrogen and manure responses are always great on the more weakly coloured soils derived from granite and ancient sediments and that these soils respond irregularly to phosphate. The phosphate response seems not to be related to laboratory determined phosphate content in the same way as the phosphate response of the deep red loams, for no responses have been recorded on examples of these soils the Mehlich determined dilute acid extractable phosphate content of which is at a level associated on the deep red loams with high phosphate responses. Dr. Whelan undertook a comparison of the phosphate distribution in these weakly coloured soils with similarly determined data for red loams from other parts of Kenya. Following the fractionation procedure of Chang and Jackson (*Soil Sci. 84* (1957) 133-144), he found the total phosphate content of the surface soil of the weakly cloured soils to be much lower than that of the red loams and that the forms in which phosphate is held by the soils were quite different:—

Form in which Phosphate is held	Weakly Coloured Soil	Red Loams
Aluminium phosphates	8–9 p.p.m.	7–8 p.p.m.
Iron phosphates	18–26 ,,	150–200 ,,
Organic phosphates	70–110 ,,	100–200 ,,
Calcium phosphates	10–11 ,,	20–34 ,,
Reductant soluble phosphates	70–110 ,,	200–300 ,,
Occluded iron and aluminium phosphates	9 ,,	50–60 ,,
Residual phosphates	34–45 ,,	Around 250 ,,
Total ..	270–280 ,,	600–900 ,,

Even where phosphates responses currently are low on the weakly coloured soils, intensive cropping should quickly run down reserves of the nutrient and lead to an increasing need for its application.

The residual effects of the FYM applications were small.

The rainfall in both 1957 seasons in Southern Province was more than usually abundant and so 16 trials were successfully completed in the long rains and 24 in the short. In fact waterlogging caused trouble at some sites and led to the failure of a number of the trials. The majority concerned either maize or potatoes and the meaned results were:—

Treatment	Potatoes Bags per acre		Maize lb. per acre	
	+	−	+	−
P direct	44·6	33·8	850	701
Residual	42·5	38·5	1,527	1,195
Manure direct	48·2	36·4	887	665
Residual	42·5	38·6	1,534	1,242
Lime	29·8	17·3		
N direct	44·5	34·8	987	915
K direct	40·3	39·0	915	987

+ with, − without.

While the potato yields were better than the Central Province average, the rainfall in many of the maize trial areas even in this year of higher than average falls was badly distributed and this particularly so in those drier parts of Machakos district where the majority of the maize trials were located. Additionally many of the trials were planted late and the maize suffered particularly in consequence, and the maize seed used was a long term maize which has now been demonstrated to be much less adapted to local climate than some of the short term varieties now under test or multiplication in the Province. Consequently average maize yields were distinctly poor. The somewhat higher yields recorded for the residual phosphate and manure maize trials are due solely to the trials concerned being located in the better watered areas of the part of the Province in which fertilizer work was in progress. On the more acid soils both here and in Central Province potato yields remained low even after liming: similar establishment difficulties (with other crops) on unlimed land to that experienced in Central Province may be expected in the bracken infested areas of this Province.

In Rift Valley, ten long rains season 1957 trials only were harvested and these were spread widely, ranged in altitude from below 4,000 to about 9,000 feet and covered a diversity of soils derived from volcanic and Basement Complex rocks. Responses to phosphate and manure were obtained on all the trials on red soils, whatever the nature of the parent material. On the more weakly coloured soils the response to phosphate decreased and to nitrogen increased as the colour became weaker: this was in line with the 1956 observations in Nyanza Province.

Fertilizer trials have also continued at all main Departmental Research Stations and on numerous alienated properties. Trials on the main plantation crops are discussed in the sectional reports dealing with those crops and on the main general agronomy stations in the sectional reports dealing with these stations.

LIME TRIALS

(Dr. L. A. Whelan)

Lime investigations received a new stimulus from Dr. Mehlich's Permanent Charge concepts and spurred us to continue the four lime cum fertilizer experiments started in 1953 and 1954 despite discouragements in the field during 1957.

At Kaptagat weed infestation was severe during 1957 and sugar beet was planted as a cleaning crop in 1958 but failed owing largly to dry weather conditions. It is hoped to continue this experiment in a simplified form by planting to a grass clover mixture and stopping the N.P.K. applications thus reducing the number of plots from 192 to 24, though all plots boundaries will remain marked. At South Kinangop kale was planted and growth was good. The main response was to the NK mixture but phosphate also increased growth. Lime appears to have had an effect. At Eldoret the 1957 wheat harvest was poor being nil on the control plots and just under one bag per acre on the best plots. No response was obtained to lime, nitrogen or potash but as in previous years there was a highly significant response to phosphate. In 1958 the area was planted to a mixture of Rhodes grass and Kenya white clover. Growth has been satisfactory where suitably fertilized and shows a marked response to phosphate and a smaller response to lime but was very poor on the untreated plots. At Marindas perennial rye grass and Louisiana white clover were planted in July 1957. The differential phosphate applications were given but the NK mixture was not applied. The grass showed good growth but there was little sign of the clover and this soon disappeared. The first cuts for weighing were taken in March 1958. Only the highest superphosphate dressing, 400 lbs. double superphosphate per acre, showed an increase (25 per cent) over the no phosphate plots and even this was not statistically significant. The mean values for the lime treatments are given below in lb. fresh weight per acre.

L_0	L_1	L_2	M		5%	1%
2,396	5,256	6,806	5,748	L.S.D.	1,054	1,429

All lime treatments show highly significant responses and L_2 is better than L_1. There is no significant difference between approximately equivalent amounts of dolomitic (L_1) and coral (M) limestones.

Subterranean clover was planted in the established grass in May 1958 but did not take. The NK mixture was given to half the plots in July and a second series of cuts for weighing was taken in October 1958. As in the first cut, only the highest phosphate application showed a response of 16 per cent and even this was not statistically significant. The mean values for the lime treatments in lb. fresh weight per acre were:—

L_0	L_1	L_2	M		5%	1%
9,157	13,821	16,444	13,622	L.S.D.	2,848	3,892

Again all lime treatments show highly significant responses and the increase of L_2 over L_1 is just short of significance at the 5 per cent level. Again there is no difference between the two kinds of limestone.

The mean values for the NK treatments in lb. fresh weight per acre were:—

Without NK	*With NK*	
10,459	16,063	L.S.D. 1 per cent 2,749

The soil samples taken over the years at the four sites are being analysed by the Mehlich rapid test technique and so far about 1000 samples have been examined. When completed the results should be of considerable value. The most interesting results to date are the values found for extractable phosphate. On the reddish brown soils at Kaptagat, Eldoret and Marindas four annual applications of each 400 lb. double superphosphate per acre raised the extractable P from a mean value of about seven p.p.m. to only 12 p.p.m. whilst the same treatment on the Kinangop grey silt loam increased it from 11 to 74 p.p.m.: the phosphate added in the fertilizer amounts in all to 140-180 p.p.m. and only on the Kinangop soil has any penetrated to the subsoil.

The Cunninghamella biological technique also introduced here by Dr. Mehlich has been used on the 1958 soil samples from Marindas and Kinangop. No evidence has been found of trace element deficiency on either limed or unlimed soils. The sulphur status was generally satisfactory at both centres and appeared to be slightly better where ammonium sulphate had been applied. The phosphate deficiency in these two soils is shown below where the figures for each treatment are percentages of the maximum growth. Soil samples were taken twelve months after the previous superphosphate application.

Superphosphate per Application After		Nil	100 lb.	200 lb.	400 lb.
Kinangop	1 application	54	60	61	65
Marindas	3 applications ..	28	30	27	42

The Marindas soil appears to be more phosphate deficient than the Kinangop, a result supported by the chemical analysis. A single small superphosphate application on the Kinangop has raised the available P level whilst three applications at Marindas showed no increase except at the highest level of application. The available nitrogen content shows very little change with lime or fertilizer treatment at either site and is much lower at Marindas (31 per cent) than at Kinangop (54 per cent). At neither site was any response obtained with cereals to applications of sulphate of ammonia but as already shown, a highly significant response was obtained on the grass at Marindas.

A study of the distribution of the chemical forms of inorganic phosphorus in soil samples from the lime fertilizer trials has been made using the methods of Chang and Jackson (*Soil Sci. 84,* (1957) 133-144). Total phosphorus varied from 880 p.p.m. P at Kaptagat and 830 at Eldoret to 640 at Marindas and 250 at Kinangop. The Kinangop soil differs from the other three in having a much higher content of aluminium phosphate expressed both as p.p.m. in the soil and as a percentage of the total mineral phosphate. On the other hand the reductant soluble phosphorus is very much less in the Kinangop soil (20 p.p.m.) than in the others which have a mean of about 300 p.p.m. This dominance of iron phosphate, especially the reductant soluble form, in the more weathered brownish soils may have a relationship to the relatively very slight increase in the extractable phosphate of these soils following superphosphate application referred to earlier. The amount of calcium phosphate expressed as a percentage of total inorganic phosphate is very low in all four soils: about four per cent. An investigation was made into the fate of four annual applications of double

superphosphate at Marindas and Kaptagat and two at Kinangop. Soil samples were taken 0-8 inches 12 months after the last application. At the three sites the greater part of the recovered phosphate was found as aluminium and iron phosphates, mostly as aluminium phosphate at Kinangop and iron phosphate at Marindas and Kaptagat. Only a small percentage of the recovered phosphate was found as calcium phosphate but previous heavy lime applications increased this as is shown in the table below. The amount of double superphosphate given per acre per application was 400 lb.

CALCIUM PHOSPHATE AS P.P.M. IN SOIL

		No Phosphate	With Phosphate
Kaptagat	No limestone	36	35
Kaptagat	8 tons limestone per acre	36	55
Marindas	No limestone	24	31
Marindas	7 tons limestone per acre	26	38
Kinangop	No limestone	7	8
Kinangop	3 tons limestone per acre	7	11

Application of a heavy dressing of limestone above has not increased the amount of calcium phosphate in these soils but it has kept more of the applied phosphate in this available form.

An estimation of the organic phosphate in the ploughed layer of the Kaptagat soil was made by the ignition $-O.2N\ H_2SO_1$ extraction method of Saunders and Williams J. *Soil Sci. 6* (1952) 254-67. The mean value was 200 p.p.m. P for the 24 samples taken. Neither the application of eight tons limestone five years previously nor the total application of 2,000 lbs. superphosphate had made any difference in the amount of organic phosphate estimated by this method.

Wheat Quality

(WHEAT QUALITY COMMITTEE AND MR. H. C. HODGSON)

The programme of field trials aimed at investigating the factors determining wheat quality and seeking its improvement in Kenya was continued. Less emphasis was placed in 1958 on examining the effects of nitrogen fertilizing for previous years' trials had demonstrated the ineffectiveness of even heavy and late applications of sulphate of ammonia or urea in improving matters. Instead, following an observation in the 1957 trials that weather conditions at harvest appeared to have an important effect on dough strength, considerable attention was focused on an investigation of the harvest weather factor. An elaborate maturation trial involving planting and harvesting differentials and a comparison of heads protected and unprotected from the weather with the maintaining of humidity and temperature records in both situations, was undertaken and the replicates of the long term quality trials were divided between early plantings and late plantings. Grain harvested from these trials is now under examination. Attention was also directed more towards determining whether dough strength was higher in wheat from newly broken vigorous grass legumes less than in wheat from old cultivation. These studies were undertaken partly by seeking participation in a farm survey programme now in progress under the aegis of Egerton Agricultural College in the wheat growing areas of Kenya, partly by using existing trials in the Department's experimental programme and partly by laying down the first of a number of long term trials specifically for the purpose.

However progress in the field aspects of wheat quality improving remains slow and so new urgency attaches to the chemical investigations of wheat gluten which we initiated in 1957. The primary aim of these investigations is to examine the possibility of a correlation between dough strength and gluten compositions of Kenya flours. The scheme entails the electrophoretic separation of the gluten constituents and a comparison of their composition pattern in flours showing a wide range of protein contents dough strengths and L/P ratios as determined by the Chopin Alveograph. 16 flours with such contrasing characteristics accordingly were selected for examination from the varieties Regent, 360H, Sabanero and 294M. Analysis figures for the nitrogenous components of these flours are given in Table 1 (dough strength, L/P and total protein data supplied by Dr. Woodhead):—

Variety	Dough Strength	L/P	Total Protein %	Salt Soluble Nitrogen %	Non Protein Nitrogen %	Gluten %
Regent	57	0·89	9·4	0·26	0·03	7·9
,,	53	0·29	12·8	0·32	0·05	10·9
,,	27	3·54	12·9	0·29	0·07	11·2
,,	49	2·92	13·4	0·31	0·05	11·6
,,	59	2·08	12·9	0·30	0·06	11·2
,,	60	1·46	14·0	0·36	0·14	11·9
360H	20	0·42	10·1	0·27	0·04	8·5
,,	47	0·69	9·3	0·20	0·15	8·1
Sabanero	14	1·51	8·8	0·25	0·03	7·3
,,	27	1·78	11·0	0·27	0·05	9·4
294M	34	0·64	8·6	0·24	0·03	7·2
,,	35	0·48	8·9	0·22	0·03	7·6
,,	22	0·42	11·2	0·29	0·08	9·5
,,	54	0·44	11·2	0·30	0·08	9·5
,,	38	0·53	11·1	0·28	0·07	9·5
,,	22	0·60	10·4	0·29	0·07	8·7

As is shown by the above table, the salt soluble protein (= salt soluble nitrogen – non protein nitrogen) representing the combined albumin and globulin fraction, is with few exceptions remarkably constant both between and within varieties. Such variations as do occur bear no relationship to either total protein content or dough strength.

The separation of the gluten proteins from other flour constituents in a preservable form without alteration of their native properties and structures was an essential preliminary to the study. This was achieved by a modification of Lusena's acid dispersion and freeze drying method (*Cereal Chemistry 27* (1950) 167). The resultant products took the form of white flaky solids capable of prolonged storage without deterioration in the refrigerator. Glutens reconstituted from this dried state were to all appearances identical with the original material. As expected, weak flours yielded highly extensible glutens with poor resistance to stretch: strong glutens on the other hand were more rubbery in nature and less readily deformed.

Filter paper electrophoresis, as widely employed in serum protein studies was tested for the seperation of gluten constituents but an acid instead of an alkaline buffer was used, gluten being denatured in alkaline solution. Under acid conditions, proteins migrate as positively charged particles in an electrical field. In the case of gluten however it was found that extensive adsorption took

place on ordinary filter paper as this carries a slight negative charge. The impedance to normal electrophoretic migration which results, causes a long streaky pattern to develop on dyeing the electropherograms instead of discrete constituent spots and much of the protein remains at the point of application. In an effort to overcome this phenomenon, filter paper strips were treated prior to electrophoresis with a variety of reagents designed to bring about the addition of basic amino, alkyl substituted amino and pyridinum groups to the cellulose molecule to reduce its adsorptive affinity. This in its turn led to further problems in connexion with the staining of the papers whereby the location of the proteins is indicated: no really satisfactory dye among the many tested gave a clear untinted background with these "basic" papers. Furthermore exhaustive trials even with these modified papers gave little improvement of the electrophoretic pattern. Apparently, extensive hydrogen bonding takes place between the protein amide groups and the cellulose hydroxyls in a manner analagous to the adsorption of an amido type dye on cellulose in an acid medium. For this reason electrophoresis on starch also proved unsatisfactory. Agar gel as a supporting medium likewise was unsuccessful. Glass fibre paper failed to bring about a separation probably due to the presence of free silica, a powerful protein adsorbent.

Fractionation of gluten constituents is possible in free solution: i.e. without a supporting medium, by the alternative method of boundary electrophoresis. Other workers have often used this method to demonstrate the heterogeneous nature of gluten. The method is however unsuitable for this particular study, since in contrast to the zonal technique it does not permit of the isolation of the separated components for individual investigation. Both methods are based on the same principles and what can be achieved with the one is theoretically possible under suitable conditions with the other. Experiments are therefore continuing using other non-hydrophilic media.

In addition to the various survey samples already listed other samples are being collected from the elaborate maturation trial. These will provide material for the investigation of the pattern of protein synthesis of early and late sown wheat during ripening. Harvests were taken at weekly intervals from an estimated three week pre ripe stage through to three weeks after full ripeness.

Crop Product Development

(Mr. H. C. Hodgson)

Geranium

A sample of Burbon geranium oiil was distilled from the plantings at the laboratory and submitted to the Tropical Products Institute for analysis and commercial assessment. A more favourable report was received on this than on the sample distilled in 1957, probably in large measure because of the wetter weather at harvest time with the latter sample. Further harvests and distillations with the aim of obtaining further quality data are projected. Meanwhile a number of commercial growers have similarly submitted samples to the trade in Britain and have received similarly favourable reports. A new trial planting was established in the Upper Kiambu Coffee Substation. Trial plantings of Kenya geranium were established in African areas at Kakamega, Embu, Mwea and in Taita Hills.

Mexican Marigold

A certain amount of interest is being shown in the pungent yellow oil of relatively high yield distilled from flowering plants of this weed. Samples have been submitted to the Tropical Products Institute where exhaustive chemical investigations are being conducted on it with a view to possible commercial use.

Banana

A specimen of the fibre banana *Ensete edulis* growing in the laboratory grounds has been processed for its fibre and reserve starch components. Samples of these products are being examined to assess the possibilities of the plant as a commercial crop in certain areas.

Citrus Juices

Seventeen juice samples from several varieties of lemons and one of lime were prepared and despatchd for commercial assessment to the Tropical Products Institute. They form the initial stage in a trial programme to investigate the possibilities of establishing a citrus juice industry in Kenya.

First reports on these samples have been quite encouraging and further stages of the programme will be carried out in 1959.

Nitrogen in Rainfall

Determination of the ammonia nitrogen content of rainwater collected at Scott Agricultural Laboratories was continued for the ninth successive year. The results from daily collections in 1958 were:—

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Rainfall	1·45	6·04	1·34	2·33	13·07	1·43	4·07	0·05	0·03	0·64	2·67	3·08
Rainy days	4	8	8	11	19	9	8	3	1	3	10	10
Ammoniacal N added by rain lb./acre ..	·174	·145	·100	·282	·889	·047	·033	0	0	·029	·134	·237
Lb./acre per inch of rainfall	·120	·024	·075	·121	·069	·033	·008	0	0	·045	·051	·077
Lb./acre per inch of rainfall (mean over 9 years)	·094	·115	·103	·077	·073	·042	·074	·115	·083	·142	·091	·073

The total rainfall was 36.20 inches. The total addition of ammoniacal N amounted to 2.071 lb./acre, equivalent to 0.057 lb./acre per inch of rainfall. The nine year mean per inch of rainfall is 0.078 lb./acre.

The investigation will be continued for one year more to complete a decade of records.

Analytical Data

The following data obtained during 1957-58 is of general interest:—

Foodstuffs and Plant Tissues

Commodity	Moisture	Oil	Crude Protein	Fibre	Ash	
	%	%	%	%	%	
Athi plains grass ..	4·5	1·7	4·2	34·9	12·1	
Brewers grains dried ..	9·0–11·4	3·0	13·0–13·3	5·6–5·8	4·4–8·8	
Brewers grains wet ..	52·0–61·2	2·4–2·7	7·7–8·2	2·5–4·5	0·6–0·9	
Bone meal	4·8	4·1	28·4			P_2O_5 24·2%
Buttermilk			0·3–0·43 W/V			
Castor seed		43·5–51·5				
Cocksfoot grass	74·4		16·2			
Cocksfoot/Bromus/lucerne/silage	72·1	1·1	6·1	7·0	3·3	pH 7·2
Coffee husks	11·9	2·6	9·3	32·9		
Copra		67·9				F.F.A. 1·41%

FOODSTUFFS AND PLANT TISSUES—(*Contd.*)

COMMODITY	Moisture	Oil	Crude Protein	Fibre	Ash	
	%	%	%	%	%	
Corn on cob meal, Ritter process	54·6	1·6	5·1	4·0	1·5	
Cotton seed cake	7·7–11·1	4·4–7·7	25·0–45·5	10·9–25·0	5·8–8·1	
Fishmeal	13·4		54·7			
Fodder Beet						
Hunsballe	81·4–85·6					
Pajberg Rex	83·7–85·8					
Yellow Otofte	82·1–84·8					
Grass seed	13·3	3·3	10·4	9·7	5·1	
Growers mash	9·9		16·9			Dig. C. Protein 14·8%
Italian rye grass silage	80·8	1·1	3·8	4·6	2·8	pH 5·0
Layers mash	11·1		14·8			Dig. C. Protein 12·8%
Liver meal	7·4	15·1	68·3			
Lucerne silage	77·2	0·6	4·7	7·3	3·2	pH 8·0
Lupin and oat silage	82·0	1·25	1·66	5·72	2·24	pH 6·0 P_2O_5 0·08% CaO 0·11%
Lupin seed						Alkaloid 0·30–1·60%
Maize bran	8·5–13·1	5·7–9·6	7·0–8·8	4·5–13·9	2·3–5·4	Dig. C. Protein 6·8% Starch equivalent 68·9%
Maize silage	77·6–87·3	0·1–0·3	0·7–1·0	4·2–9·4	1·0–3·6	pH 5·0
Meat meal	6·2–8·1	8·2–8·5	49·0–68·5			P_2O_5 5·3–13·9%
Napier grass	75·9	0·3	2·5	9·1	2·2	
Napier/Sanal hybrid	84·0	0·3	2·7	4·8	1·0	
Oat hay	12·0	2·7	8·3	28·4	6·9	
Oat silage	64·7–85·0	0·5–0·8	0·4–2·3	6·7–14·7	1·8–3·3	pH 4·4–5·6
Oats metabisulphite silage	63·7	0·5	3·9	14·2	5·1	pH 8·5 SO_2 160 ppm.
Oat straw	4·9	1·5	7·7	33·9	6·8	
Phalaris tuberosa silage	71·9–72·7	0·9–1·4	5·2–5·9	6·0–7·8	4·8–6·1	pH 6·0–7·7
Pineapple juice	87·2		0·34			
Pineapple peeled	87·5	0·03	0·33	0·4	0·3	
Pineapple residues dried—						
Cores	5·8	3·5	3·9	20·0	4·0	
Skins	2·6	4·3	8·2	21·3	7·8	
Tops and bottoms	3·8	4·0	8·3	20·4	7·0	
Pineapples whole	86·3	0·04	0·4	0·7	0·3	
Poultry mash	3·3–3·8	4·1–5·1	18·1–22·2	7·1–8·5	2·8–4·6	Dig. C. Protein 16·0–20·1%
Pyrethrum leaf—						
Unfertilized	8·50					P_2O_5 0·31%
Fertilized with 450 lb. triple supers per acre	8·81					P_2O_5 0·45%
Rape silage	80·6	0·8	2·2	3·9	2·4	pH 4·2
Rhodes grass	63·2–75·0	0·3	2·0–4·5	8·2	2·7	
Rhodes grass silage	78·8	0·5	1·7	7·4	2·8	pH 4·8
Rice dust	10·1–10·4	3·3–18·6	5·0–12·9	9·3–33·6	11·9–19·1	
Russian comfrey dried	3·5–19·0	0·8–2·5	16·7–18·0	9·4–10·0	13·6–20·7	
Russian comfrey silage	63·6–84·8	0·5–1·4	1·3–6·1	3·9–14·2	2·4–5·1	pH 4·2–8·4
Rye grass silage	82·3	1·3	2·9	5·9	3·0	pH 5·0
Sunflower meal	9·6	18·5	14·8	25·9	6·1	
Sunflower seed		18·3–38·9				
Soya beans	6·9	17·3	40·2			
Uplands trio mixture	6·2–10·0		41·0–42·5			
Wheat bran	9·4	5·0	15·8	9·5	6·0	
Wheat straw	5·8	0·6	3·2	38·9	5·1	
Wimbi bran	9·8	1·2	9·6	16·8	7·1	
Zebra meal	9·4	4·2	77·1	4·7	4·6	

Commodity	Moisture	N	P205	K20	Ash	
Manure or Mutch	%	%	%	%	%	
Ash						CaO 33·7–42·1% MgO 1·8–2·8%
Basic slag..	0·4		17·3 Cit. sol.			
Bat guano	12·3 – 27·3	0·5– 8·6	1·6– 7·9		20·2– 26·0	
Boma manure	8·9	1·4	1·2	2·6	59·4	
Bone meal	6·6	4·2	24·8			
Cattle manure	57·0	0·8	0·3	0·1		
Compost	44·3– 49·0	0·6– 1·2	0·6	0·6		
Deep litter	16·2	1·9	2·3	1·6	41·4	
Farmyard manure ..	31·8– 41·3	0·85– 1·15	0·52– 0·77	2·22	33·1	
Grass	10·4	0·59	0·09	0·56		
Guano	13·0	25·4	0·2			
Gypsum	15·2			0·1		CaO 18·4–27·5% MgO 0·5% SO3 30·5–37·3% Acid insolubles 7·6–22·3%
Hoof and horn	7·2	14·2				
Hyperphosphate	2·4		13·0 Cit. sol.			
Limestone	0·5– 1·0				82·6	CaO 33·7–42·1%
Manure air dried ..	4·1– 10·3	0·8– 2·1	0·3– 8·5	0·7– 2·7		
Meat product manure ..	4·1	5·8	15·9			
Papyrus grass	12·1	0·93	0·31	0·42		
Poultry manure	8·7	3·1	4·0			
Sewage sludge	8·6– 50·0	0·3– 1·0	0·9– 1·7	2·3	31·8– 56·1	CaO 1·07%
Seychelles guano ..	6·8– 12·0		24·4– 32·7			
Sheep manure	54·0	0·9	0·3	0·1		
Sisal waste	9·0– 33·0	0·79– 1·22	0·23– 0·28	0·44– 0·52	33·2	CaO 7·73%
Soda phosphate	1·3– 4·2		19·9			Cit. sol. P205 16·1–19·1%
Soda phosphate fortified			17·1– 17·2 Cit. sol.			CuO 109 ppm.
Superphosphate			41·7– 45·9			
Tobacco dust	8·2	3·2	0·6	4·3	20·8	
Uganda rock phosphate..	1·4– 1·9		22·1– 23·6			Cit. sol. P205 2·4%

Publications

Bellis, E., Notes on Kenya Agriculture. (2) Tabulated recommendations for manuring and fertilizing in African areas. *E. Afr. Agric. J.* 23. 234.

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E. BELLIS,
Senior Soil Chemist

ANNUAL REPORT OF THE SENIOR PLANT BREEDER, 1958

I—Review of the Year

Rainfall in the wheat growing areas during 1958 was exceptionally prolonged in duration, with unusually damp conditions in July and August and little sunshine. As a result yields were somewhat below average in most of the lower to middle altitudes regions which, in addition, experienced a wet harvest. In the higher areas rain ceased in time for crops to ripen into drier weather and, consequently, yields were generally higher than average. The rainfall recorded at Njoro is quoted in Table I.

TABLE I—NJORO RAINFALL, 1958

MONTH	1958	29 year average	MONTH	1958	29 year average
January	2·27	1·01	July	6·61	4·40
February ..	5·08	1·38	August ..	4·98	5·07
March	5·83	2·72	September ..	4·78	2·72
April	4·73	5·43	October ..	2·79	2·01
May	8·56	4·50	November ..	1·36	2·57
June	1·69	3·32	December ..	3·02	1·86
			TOTALS ..	51·70	37·00

The high-light of the new developments was the occupation of the new laboratories in May followed by their official opening by Major the Hon. Sir Ferdinand Cavendish-Bentinck, C.M.G., on 29th August. The 200 acres of extra land adjoining the station, which were purchased in 1957, were further developed and the first field cropped to pedigree wheat production as the first step in the 7-year rotation adopted. The breeding team at Njoro was strengthened by the arrival of a third Plant Breeder, making five in the section as a whole. A Cereals Research Advisory Committee has now been set up to advise the Director of Agriculture and, through him, the Minister for Agriculture, on policy matters relating to cereals research. This committee held three meetings during the year and has already proved its value in strengthening the liaison between the breeding team and the farmers and by the exchange of ideas on breeding problems.

The station is now equipped with modern facilities, increased staff, and, on the field side, possesses adequate land and a considerable range of implements and specialized machinery for the expanded programme which is now well under way.

At Kitale the programme to produce higher yielding maizes is settling down to steady progress following the rapid expansion of the last two years and the breeding policy continues to be based on a joint programme of synthetic and hybrid production. The next expansion phase is dependent on further funds being available and an approach has been made for assistance in this respect both to local maize growers and to the Colonial Development and Welfare Fund. At Machakos the programme of breeding short-term maizes, now in its third year, achieved considerable success. Much use has been made of the quick maturing variety Taboran which in crosses with various early imported, as well as local, maizes has shown most promise as breeding material.

II—Survey of Field Crops

Wheat has fallen by some 13,000 acres from the 1957 season; the total drop over the 3-year period 1956-1958 is thus 102,000 acres (30 per cent). The maize acreage has also shown a drop of 37,000 acres (23 per cent) and oats 4,000 (13 per cent) from last season. The barley acreage is unchanged. The relevant information is summarized in Table II below.

TABLE II—CEREAL ACREAGES, 1954–1958

YEAR	WHEAT		MAIZE		BARLEY		OATS	
	Acres '000	Bags/ acre	Acres '000	Bags/ acre	Acres '000	Bags/ acre	Acres '000	Bags/ acre
1954..	291	5·10	174	9·11	29	7·30	22	7·02
1955..	345	3·93	158	7·89	24	6·62	19	6·72
1956..	316	4·43	166	7·67	42	7·29	25	7·85
1957..	239	4·78	167	8·04	52	6·67	26	6·88
1958..	235	4·56	124	9·37	56	6·70	21	6·86

(Bags = 200 lb. net for wheat and maize; 180 lb. net for barley; 150 lb. net for oats)

VARIETIES

The main wheat varieties grown during the season and their acreage percentages for the 3-year period 1956-1958 are shown in Table III. Advice on the choice of varieties for the season was given to farmers in the yearly broadsheet "Cereals for 1958/59 by H. C. Thorpe and G. E. Dixon", which appeared in the local Press (K.I.O. Fortnightly No. 451 of February, 1958).

TABLE III—WHEAT VARIETY ACREAGES, 1956–1958

VARIETY	1956	1957	1958
	per cent	*per cent*	*per cent*
362	1·3	7·4	11·1
D.C. × Ceres	8·1	5·5	10·1
Sabanero	21·7	25·4	9·5
1066	7·6	9·6	7·9
Equator/Baby Equator	11·5	12·7	7·9
358	0·8	3·0	6·2
Regent	4·9	2·8	5·8
Hopeful	—	3·4	4·8
363	—	1·1	4·3
294	6·2	3·9	4·2
131	11·0	10·1	3·4
H.462	—	—	3·3
Impala	—	1·8	2·2
Others	26·9	13·3	19·3
	100·0	100·0	100·0

The main difference in the pattern of varietal distribution when compared with 1957 lies in the wider spread of varieties with less emphasis on any one of them. For example, the variety Sabanero which in 1957 formed 25 per cent

of the total acreage dropped this season to 9.5 per cent, and the acreage sown to the first three varieties correspondingly fell from 38 per cent in 1957 to 31 per cent this season. Two special changes are worth pointing out; the 362 group of varieties has risen from fifth to first place this season due to adaptability and good yielding powers in the higher areas, and 131 fell from third to eleventh place due to poor yields and disease damage. The policy of a price differential with a higher price of wheats of good baking quality, and a lowered price for those of poorer quality, led to an increase in acreage of the first class of wheats from 10 per cent in 1957 to 20 per cent during the present season and a corresponding drop in acreage of poorer wheats from 72 per cent to 60 per cent. Unfortunately, as stated earlier, this policy failed owing to heavy leaf rust attack on the quality wheats which led to greatly reduced yields in this group.

Regarding barley, the great increase of leaf diseases during the past two years has quite seriously affected confidence in the crop and it is likely that, in the absence of suitable disease resistant varieties, the acreage may decline during the coming season. Oats continue to be very susceptible to rusts in Kenya and this limits their cultivation. The standard feed oat remains the Australian variety Lampton and Grey Algerian is still the standard porridge variety. The Canadian variety RL 1734 continues to maintain a satisfactory field resistance to rust and is popular as a feed and fodder type. A further Canadian variety 3003.F released in 1956, has shown more susceptibility to rust and has consequently declined in acreage. (This variety is now understood to be known elsewhere as Lanark.)

The first Njoro Synthetic maize released for 1957 planting continues to yield well in certain areas and the first Kitale Synthetic was released for planting during the season.

Diseases

Regarding diseases of wheat, stem rust (*Puccinia graminis*) has not been serious and, in this respect, the season resembles 1957. Nevertheless a stem rust survey showed that there were seven races currently prevalent during the season (K12, 13, 14, 16, 17, 18 and 19), and a new race K20 is suspected. In contrast, brown leaf rust (*Puccinia triticina*) was wide-spread and very damaging in its attacks. The quality wheats consisting chiefly of the Canadian varieties, D.C. × Ceres, Mida-Cadet, RL 2150/A, Regent and Reward were particularly severely affected and both yield and grade reduced in consequence. Last season it was recorded that this rust had been more virulent than for some years past but an attack on the scale actually experienced this year was quite unexpected. Yellow leaf and ear rust (*Puccinia glumarum*) was little in evidence but glume blotch (*Septoria nodorum*) caused damage particularly in the Canadian varieties mentioned above which are known to be susceptible to the disease.

Of the root diseases, both *Pyrenophora* and Take-All were prevalent in Western Kenya particularly in the Moiben Valley. However, there has been a notable reduction in both these diseases on the Kinangop where they caused much damage in past years. This is considered due to a shortening of the rotation and to the sound policy now pursued by farmers in taking only two successive wheat crops from breaking. In addition, infected fields have largely gone out of cultivation with the reduction in wheat acreage in the area. Nevertheless, the leaf phase of *Pyrenophora* was extensive during the season, probably a reflection of the wet year which has been experienced.

Net blotch of barley (*Helminthosporium teres*) was widespread and damaging; in addition, spot blotch (*Helminthosporium sativum*) and scald (*Rhynchosporium secalis*) caused much damage. All the commonly grown varieties are

almost equally affected and little varietal differences in resistance are apparent. As already emphasized this group of leaf disease have increased materially over the past two seasons and now form a serious threat to barley production in the country. It is always possible that a return to drier seasons may have the effect of checking these leaf diseases.

III—Breeding—Wheat, Barley and Oats

With plot work now established at Naro Moru and Endebess as mentioned in last year's report, the out-station programme has been established on the basis of seven sites for district work. During the year the programmes at all sites have been increased to provide adequate local testing of the increased volume of material being produced from the main station at Njoro.

New Accessions and Crosses

The nurseries continue to provide the most important source of new material, but 65 new wheat accessions were obtained from other sources. Unfortunately they generally proved far too susceptible to stem rust to merit further study. The exceptions were two of the derivatives from the cross (*Triticum dicoccoides* × *Aegilops speltoides* amphidiploid) × Austin^2, received from Texas, and the varieties Zipa from Colombia and Fontaleza from Argentina.

Five collections of wheats from the Rockefeller Foundation's programme in Mexico were grown in 1958, totalling over 2,700 plots for selection. Much of this material rusted heavily or proved specially susceptible to glume blotch, but selections have been made in the more promising lines. A more detailed appraisal of this material will be made after a further season. Selections from the earlier collection from Columbia (1956) again suffered badly from stem rust although showing useful levels of resistance to yellow leaf rust. However derivatives from 17 crosses are being continued, of which the most attractive are II-1476 (Kentana 48 × Ciento Cincuenta), and II-3475 (Mentana—Kenya × Frontana × Cinco).

The most important feature of the wheat crossing work for the season was the start of an entirely new programme of intensive back-crossing. Two collections of parental material had been gathered together representing the best possible sources of resistance to stem rust and to stripe rust, numbering 188 and 153 varieties respectively. All the former were crossed to five wheats of known local value, namely 184.P, 294.M, 354.P, Regent and 362.B.1.D.3.D. These 188 first crosses have now been replanted for the initial backcrosses to be made out of season under irrigation early in 1959, and in this way it is proposed to push this material ahead as rapidly as possible for use either in composites or as pure line varieties depending on how it develops.

Meanwhile the final stages of the earlier backcrossing work involving 84 crosses have been taken through two further generations. Backcrossing itself has ceased and the majority of the material is being selected as F_2's and F_1's of mainly second and third backcrosses, together with some multiple crosses. The outstanding parent for stem rust resistance in these crosses is undoubtedly CI.12632 from Wisconsin, which is an (Illinois 1 × Chinese^2) × *Triticum timopheevi* derivative. Mida-McMurachy-Exchange, II-47-26, from Minnesota has also given valuable resistance but not so consistently. From the Kenya side, the crosses involving 360.H have been most impressive; those based on 358.AA showed special vigour but have not held promise on rust resistance.

Mention must also be made of the 31 advanced generation crosses from the 1955 and 1956 seasons, involving some 600 selections. These proved disappointing in many cases and there has been a marked reduction of this material. However some initial out-of-season bulking is now under way from certain of them, of which the most valuable are Cross 1016 (360.H × Frontana-Kenya 58-Newthatch), and Cross 1019, (360 × Mida-McMurachy-Exchange).

The seven barley crosses were transferred to Molo this year for evaluation under high altitude conditions, and in fact suffered severely from scald. A repeat sowing at Njoro, on a field infected with net blotch, has allowed further selection against this important disease, but the levels of resistance to these two diseases are not very strong and they are not apparently correlated.

An interesting group of 13 barleys for resistance to net blotch was specially obtained from California. An artificial infection was induced and the control variety Research developed the disease quite strongly, but these new varieties remained free. On the other hand their attractiveness in other directions was poor and almost all (notably the Manchurian types), suffered severely from yellow leaf rust. It seems that the current epidemic of barley leaf diseases will not readily be solved by the direct introduction of further varieties from abroad; resistance will have to be dealt with as a breeding project.

Nurseries

The International and F.A.O. Nurseries were again grown on a considerable scale, with duplication at Endebess, and now Naro Moru also playing an important part in this work. In addition a special stripe rust (yellow rust) addition to the International Wheat Nursery was sown at Molo. This material proved extremely valuable, especially that entered from Ecuador and Peru, and a large proportion of these varieties will be repeated for further observation.

In the six years since this nursery work began some 3,600 wheats and many barleys and oats have been grown, and over 400 have been chosen for further study; in 1958 alone the total number of these nursery plots was 2,300. It can be seen that this represents an extremely valuable supply of new material; this point is stressed for it makes the work on these projects especially important. The one disappointment is that there is so little in the oat nursery offering any useful measure of rust resistance under Kenya conditions. Progress with oats has thus been delayed.

District Trials and Observations

The wheats under trial for low and medium altitude areas were again mainly foreign varieties extracted from the nurseries of earlier years. For the former, Kentana 54B and Kenya-Frontana-Mayo showed special promise at Endebess; and Africa × Mayo 48 and Wis.245 × Supremo were the outstanding varieties at Rongai and Naro Moru. In the medium altitude range (Njoro and Eldoret), Rushmore-Surpresa, Veranopolis, Vaedeiro and Frontana-Kenya 58-Newthatch have all done well. Mentana^{2}-Kenya C9906 was outstanding at Njoro, but both this and the Frontana type have had to be withdrawn on account of increased stem rust susceptibility.

For the higher altitudes, the 384 and 385 series of wheats were again under trial. Full results are not yet available, but the yield levels continue to be satisfactory and these wheats should provide a significant improvement in the range of varieties available (*see* section on Releases).

MULTIPLICATION

This has been a very disappointing year for the multiplication of new wheats for the low and medium altitudes; all four varieties destined for these areas have had to be withdrawn due to stem rust attack. On a farm scale both Spica and Rio Negro mentioned last year rusted severely and had to be abandoned. More seriously, since they had both shown outstanding vigour, both Frontana-Kenya 58-Newthatch, II-50-25, and Mentana^2 × Kenya C9906 have had to be discarded for the same reason even though yields were extremely good. Fortunately another alternative selection of the Frontana Type is available which may replace selection 25 satisfactorily; this is number II-50-18 which is being given accelerated multiplication accordingly. In the higher altitudes the situation has fortunately been entirely different, as described below in the section on Releases.

No new barleys or oats were under general multiplication this season, though some small scale preliminary increase of three barleys was begun at Njoro and the Department obtained a bulk importation of Frontier barley from Wyoming for use in the Eldoret area.

RELEASES OF NEW VARIETIES

Seven new wheats have just been released for 1959, as shown in the following table. Full details have been published in the local Press and will shortly appear in the *East African Agricultural Journal.* (The previous release of seven wheats and a barley for the 1958 season appeared in the article "Release of New Cereals —1958" by H. C. Thorpe and G. E. Dixon, in the *East African Agricultural Journal,* Vol. XXIV, No. 1 of July, 1958.)

TABLE IV—VARIETIES RELEASED FOR 1959

VARIETY NAME	Selection	Parentage	Altitude Range
Kenya Curlew ..	384.C.7.A.2	Equator × 318.AJ	7,400–9,000
Kenya Eagle ..	384.E.3.E.1	Equator × 318.AJ	7,500–9,000
Kenya Hawk ..	384.E.3.H.1	Equator × 318.AJ	7,500–9,000
Kenya Buzzard ..	384.BU.22.M.1	Equator × 318.AJ	7,500–9,000
Kenya Dove ..	385.D.4.C.1	Equator × K.P.	7,500–9,000
Kenya Plover ..	385.P.6.A.3	Equator × K.P.	7,500–9,000
Kenya Quail ..	385.Q.3.C.1	Equator × K.P.	7,500–9,000

K.P. = Kenya Ploughman = 318.0.3.B.2.

These varieties are all closely related and generally similar, except that the first five are white-grained and the remaining two red-grained. So many rival selections would not normally be released together but there have been excellent crops of all of them and, rather than delay pending further trial, it has been decided to release the seven immediately.

A point of special note is the use of names. The familiar Kenya numbering system undoubtedly causes confusion in practical use, and it will now be the policy to issue new varieties under names, keeping the "Kenya" prefix which is well established and appreciated overseas.

IV—Breeding—Maize and Sorghum

The four programmes continued during the year at Njoro, Kitale, Machakos and the Coast, as follows.

NJORO—MAIZE

Synthetic I was formed as explained in last year's report and an initial increase to 400 lb. of seed has been obtained in isolation on the new land this season. This will now sow a 25-acre block for the main multiplication in 1959.

A top-cross trial for the evaluation of a variety of older inbred lines has shown a number to be of merit and the best of these will be under further trial in 1959 before their utilization is decided.

The continuing value of Njoro Synthetic I has been demonstrated by field reports from farmers and this maize came second in yield at Njoro in trial. It yielded 28 bags/acre, compared with 22 bags/acre for the trial as a whole. Considerable further selfing work has now been carried out in Synthetic I for evaluation against the new Synthetic II, with a view to the production of Synthetic III. Meanwhile the performance of the hybrid Syn I × Syn II is to be investigated. This will not only be of interest on theoretical grounds, but may very well have important practical value.

KITALE—MAIZE

The general picture of Kitale maize breeding is that, while the main synthetic and hybrid programmes continue with reasonably good success, the search for outside sources of breeding material to give good crossing values with the local Kenya Flat White type of maize is proving very difficult. Kitale Synthetic I has had a moderate success among farmers in the Trans Nzoia and, in Kitale trials, averages about 10 per cent greater yield than ordinary maize. Kitale Synthetic II was formed by crossing the 11 component lines in all possible single crosses; this first full orthodox Synthetic from Kitale shows good promise, though two further years of bulking and trial are needed before it is ready for release.

Amongst a considerable amount of detailed work in progress at Kitale, two important points can be mentioned. In the new cycle of breeding, use is now being made of a selected mixture of the best local farm stocks as well as the Station Synthetic. Turning to the older material which has been under final trial, none of the inbreds has given top-cross yields greater than 10 per cent above the station maize and they will therefore now be discarded. In addition, there has been considerable progress in the Endebess programme, and a large number of excellent entries are available for top-cross trial in 1959.

Past work has repeatedly shown that hybrids from other countries are not good performers in Kenya. An attempt is now being made to explore the use of inbreds from abroad and to identify varieties suitable for extraction of inbreds under local conditions of selection. Two trials, one of 13 components of hybrids from Southern Rhodesia and the other of ten advanced generation Njoro inbreds, failed to show any really good yielders. Again, 25 varieties from South, Central and East Africa, in a trial of their crosses to Kitale Synthetic I, were also disappointing. The crosses yielded better than the varieties, but the Synthetic still outyielded them all. The difficulty appears to be that the Kenya Flat White type of maize is so outstandingly well adapted to local conditions that no imported variety can approach it.

Selection for resistance to leaf blight (*Helminthosporium turcicum*) and rust (*Puccinia sorghi*) is now a routine part of the breeding programme. A spray trial this year designed to give an estimate of losses due to these diseases, has confirmed the great importance of this aspect of the work. The spray used was the fungicide Zineb and this was compared with a control of no treatment with five replications, giving the results which are tabulated.

TABLE V—MAIZE SPRAYING TRAIL—KITALE

	Yield Bags/ Acre	Good cobs per 1,000 Plants	Diseased Cobs	Blight* Score	Rust* Score
Sprayed	23·3	690	5%	1·0	0·5
Control	17·7	580	10%	2·0	1·0

(*Scale 0–5).

This result clearly underlines the practical importance of leaf blight and rust, and shows why foreign varieties which normally develop heavier infections yield poorly by comparison. An alternative explanation for the improved yield is that the zinc in the Zineb had a stimulating effect. The treatment was of course used entirely for experimental purposes; it is not an economic proposition.

A new feature this year has been the laying down of ecological trials to assess the need for separate programmes in different areas and to identify the best stocks for breeding purposes; 25 stocks were in trials at six centres. The trials also offered an opportunity for a general comparison of synthetics bred at Njoro and Kitale and by E.A.A.F.R.O. at Eldoret. Conditions favoured Kitale area entries and these generally did well at most sites.

KATUMANI—MAIZE, SORGHUM AND BULRUSH MILLET

Work on the testing and breeding of short-term white maizes continued. The variety Taboran was compared with various local stocks and the variety Marsabit was also tested. The results show that the local Machakos maizes yield best, at least in the good seasons so far experienced; Taboran and Marsabit are appreciably earlier but their potential yield is less. It is considered that Taboran has sufficient merit to be of use in the drier areas of Machakos and it is accordingly being bulked for future issue. It is visualized as complementary to rather than as a replacement for local white maize.

The breeding programme at present utilizes three sources of variation. They are (*a*) local white maizes, (*b*) a panmixis of local white and early Wisconsin hybrids, and (*c*) varietal crosses with Taboran. In addition, further sources of potentially useful variation are being sought by making crosses from the varieties Marsabit and Taveron (another early variety) using a range of early and local maizes as pollen parents. The local white maize stocks have undergone selection and inbreeding for earliness, as indicated by time of silking. The seed of the seven earliest S3 lines was mixed together and sown in isolation under irrigation in August. The harvest has now provided mother seed from which the new early synthetic will be produced. In addition some 350 selections from the Local White/Wisconsin hybrid panmix have given promise of extreme earliness, though it is not yet clear whether they will have satisfactory yield potential and white blight resistance.

The Taboran crosses appear to be the most promising source of variation encountered so far, and a number of potentially useful crosses have been selected for inbreeding. These are Taboran × W255, Taboran × W341A, Taboran × Katumani Yellow, Taboran × K64, Taboran × M14 and Taboran × M15. In view of the promise of these first inter-varietal crosses, further such crosses have been made between the three varieties Taboran, Marsabit and Taveron and an extended range of early and local types. It seems however that the Marsabit series are disappointing. Other maize projects in hand include green-house studies

on comparative drought resistance of various maizes and the initiation of a programme to assess the importance of white blight damage in the early maize material, and develop blight resistant lines within it.

In work on Sorghum, observation of new types has continued but the same problem remains: no varieties have been found which combine palatability with bird resistance. Also, no sorghum of comparable quickness of maturity to the early maizes has been found. Close liaison with the E.A.A.F.R.O. breeding work at Serere (Uganda) is being maintained and testing of potentially bird-resistant palatable sorghums continues. A study of the relative reliability of short-term maize and sorghum has begun at Katumani but no results are yet available.

Observational results on bulrush millets have revealed promising heavy yielders, and some very long-awned types. Six varieties are now in yield trials, both protected and unprotected from birds. Because of the problem of bird damage the value of the potentially high-yielding types in Machakos District is doubtful; and it remains to be seen whether long awns are an efficient protection.

Coast—Maize Resistant to *Polysora*

The further multiplication of the first stock of maize resistant to *Puccinia polysora* was undertaken on the irrigation scheme on the lower Tana River at Hola, yielding 70 lb. of elite and 14 bags of bulk seed. The level of resistance continued to be extremely satisfactory (99 per cent) and this maize shows considerable promise. Efforts to continue the development of backcross material involving gene Rpp2 were foiled by the total lack of germination in the seed; this had had to be held over in store at Kwale during 1957 and had died in the meantime. Rival selections not scheduled for sowing are still fully viable: this underlines the problem of safe storage of seed at the Coast.

V—Other Investigations

Wheat Quality

Field trials in connexion with these investigations continued during 1958 but results are not yet to hand. Considerable time and effort is still being given by the Department to this co-operative project in collaboration with E.A.A.F.R.O. and Unga Ltd.

Rust Control

Maneb was again used at Njoro in an attempt to control stem rust in wheat, but due to the much wetter season was unsuccessful. Stem rust developed on susceptible varieties as if no treatment had been given, in spite of repeated applications. This result is of special interest in view of the degree of success achieved in the exceptionally dry conditions of 1957.

Soya Beans

A collection of soya beans from Nachingwea has proved of considerable interest. At Njoro nearly all remained vegetative, but encouraging results have been obtained at Katumani and nine varieties are now in trial there. Others suitable for fodder have been passed to the Pasture Research Officer. Soya varieties have also been under preliminary investigation at Hola on the Tana River Irrigation scheme, again with some useful results.

VI—Publications

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VII—Acknowledgments

The help given by the staff of E.A.A.F.R.O. and Unga Ltd., is again gratefully acknowledged: Messrs. Rohm and Haas of Philadelphia have also once more provided rust control chemicals. With regard to breeding material the wheat collections kindly provided by the Rockfeller Foundation in Columbia are acknowledged with special thanks.

H. C. THORPE,
Senior Plant Breeder.

ANNUAL REPORT OF THE PLANT PATHOLOGIST, PLANT BREEDING STATON, NJORO—1958

During the year the work on wheat stem rust has been moved from the Scott Laboratories, Nairobi, to the Plant Breeding Station at Njoro, where more extensive facilities are available. Close liaison has however been maintained with the plant pathology section of Scott Laboratories.

The general policy for the work during the year has been to move towards a "factory system" of testing rust collections; a considerable amount of time has been spent in obtaining apparatus and evolving new techniques. The full effect of the policy has not yet been felt, but the eventual aim is to reduce the amount of work involved in the routine testing of rust samples and thus to make more time available for fundamental investigations into the nature of the rust problem in Kenya.

As in previous years, testing of rust collections has been confined to stem rust of wheat, but plans have been laid for work on other rusts as soon as materials and facilities allow. In particular, investigations into yellow rust (*Puccinia glumarum*) will begin as soon as a supply of seed of the differential varieties is received. The number of stem rust samples tested has been increased from 72 in 1957 to 221 in 1958. Sampling at about this level should give a sufficiently accurate picture of the general stem rust situation. If sampling of other rusts is eventually raised to a similar level the work involved will be considerable.

Seven of the races of stem rust previously identified in Kenya occurred during the year. Race 11, which was found only once in 1957, and race 15, last found in 1955, were not identified in 1958. Races 1 to 10 have not been identified in recent years. The balance between races is shown in the table below, which is based on the results of 202 race identifications completed by 31st January, 1959. The 1957 results are included for comparison.

Race	*Number of isolations (percentage of total)*	
	1957	*1958*
K11	2	—
K12	7	18
K13	14	10
K14	5	16
K15	—	—
K16	34	20
K17	13	6
K18	14	16
K19	11	13

(*Note.*—In the above table, two or more isolations of the same race from a set of experimental plots at a single site are treated as one record only. All isolations from farm crops are considered separately.)

The most important point which emerges from the table is that no one race was markedly dominant during 1958. Race 16 was the most common, but by a smaller margin than in 1957. Races 12 and 14, on the other hand, showed a marked revival. Two new races were suspected during the year, one was eventually decided to be identical with race 13, confirmatory tests with the other have not yet been conclusive. If confirmed, this race will be the twentieth identified in Kenya.

All race numbers quoted are based on the local set of differential varieties and are not related to the system of race identification used in other countries. It is now planned to adopt the international system as far as possible, with the use of additional differential varieties to separate local biotypes. This change will lead to an easier exchange of information and material with plant breeders in other countries. Many of the Kenya rust races have been identified on the international system by previous workers; the work was continued during 1958 but was hampered by a shortage of seed of the necessary differential varieties.

Forty-four cereal disease advisory specimens were dealt with during the year, details of which are included in the report of the Senior Plant Pathologist.

E. J. GUTHRIE,
Plant Pathologist.

ANNUAL REPORT OF THE COFFEE RESEARCH STATION, RUIRU, 1958

For the fourth successive year heavy rainfall was experienced during the dry season prior to the Long Rains. After abnormal showers in January heavy rainfall was recorded throughout the coffee areas in February. As in the previous year these conditions favoured a rapid recovery from the effects of crop strain, but engendered a build-up of leaf rust infection prior to the Long Rains. As in the previous year the consequence was that rust attained epidemic levels in all districts East and West of the Rift in the latter half of the year while the crop was maturing on the tree. In the East Rift districts in particular defoliation was severe due to rust and to widespread attacks of leaf miners in most districts. Although good rain in July served to alleviate the effects of defoliation to some degree the rainfall during the second half of the year was well below average except in Makuyu and Trans Nzoia districts. Consequently yields were heavy but quality was generally poor.

Unlike the previous year, however, coffee berry disease infection declined generally during the latter half of the year, an effect attributable to dry weather and the widespread use of fungicidal sprays in the zones normally subject to the disease.

RAINFALL AT THE DEPARTMENT'S COFFEE STATIONS DURING 1958

	A	B	C	D	E
January	2·23	1·45	1·98	3·10	2·68
February	9·41	6·04	2·34	5·49	6·04
March	4·44	1·34	3·40	4·83	7·99
April	7·63	2·33	15·69	2·26	11·22
May	17·91	13·07	14·01	5·49	9·63
June	2·29	1·43	0·65	12·10	7·39
July	4·13	4·07	1·38	4·20	4·47
August	0·02	0·05	0·00	8·56	6·67
September	0·18	0·03	0·25	4·76	6·91
October	0·98	0·64	2·59	3·94	9·40
November	3·05	2·67	7·54	0·79	2·61
December	2·86	3·02	2·78	1·83	5·32
TOTAL	55·13	36·14	52·61	57·35	80·33
No. of days total ..	130	94	107	140	174

A.—Coffee Research Station, Ruiru.
B.—Scott Agricultural Laboratories, Kabete.
C.—North Kitito Estate, Makuyu.
D.—Kitale Experimental Station.
E.—Experimental Farm, Kisii.

Depredation of insect pests continued to cause concern to the Industry, tip stem borer and leaf miners particularly. Much of the Entomologist's attention was directed towards acquiring a better understanding of both pests and improved methods of chemical control of leaf miners were developed. Since lacebug is now attaining outbreak levels generally in the West Rift annually and spreading northwards East of the Rift, it is fortunate that an easy and effective control measure is available in the use of Malathion sprays.

The study of leaf rust and its control was limited by the absence of the Plant Pathologist on sick leave for most of the year. As a result of investigations carried out at the Coffee Rust Investigation Centre in Portugal, supported by local studies conducted at Ruiru, a clear picture has now emerged of the reaction of resistant strains of coffee to the Rust Races locally endemic and the distribution of the latter is becoming clearly defined. Confirmation of these conclusions will be required and the Rust Exposure Trials sited in the main coffee growing districts are designed for this purpose. As reported by Mr. Hanger, observations made to date in trials in African districts support the reaction pattern postulated by Dr. d'Oliveira in Portugal.

During the five years since the airblast spraying technique was introduced the method has been adopted into normal estate practice. Trials to assess the response to tonic copper sprays when applied by airblast methods have shown the value of higher concentrations of copper fungicide in obtaining full yield response with lower volumes of water. This differs from previous conclusions in that trials operated with hand lances have not hitherto generally indicated the need for concentrations higher than 1 lb. of 50 per cent copper fungicide per 15 gallons of water.

In Agricultural Chemistry the emphasis of Mr. Robinson's work has shifted from nitrogen to a detailed examination of the circumstances which give rise to the magnesium deficiency syndrome in the tree. Good progress in elucidating the problem was made during the year. In particular, attention was devoted to employing mulch grass species with low potash contents, and to assessing the effects of magnesium fertilizer dressings on the tree and crop in conjunction with grass mulching as a routine practice.

After much initial delay the programme for expanding coffee research was put in hand during the year; a new substation was opened in Upper Kiambu and some of the additional laboratory staff entailed in the programme were appointed. With the inception in December of one further new station at Koru in Nyanza and financed directly by the Coffee Board, the total number of substations becomes five plus two minor stations. This represents a good coverage for the diversified conditions prevailing in the coffee areas of the Colony.

A fully comprehensive record of all investigations undertaken during the year will be included in a separate report covering the 1958/59 crop season. This report, constituting the third separate annual record of the Coffee Research Station and containing full yield data from field experiments, is scheduled for publication in July, 1959. Copies will be obtainable from the Coffee Research Station, Ruiru, or from the Coffee Board of Kenya, Etco House, Nairobi.

Publications

Bock, K. R., Robinson, J. B. D., and Chamberlain, G. T.—Zinc deficiency induced by mercury in Coffea Arabica. *Nature*, 1958, 182, No. 4649, p. 1607.

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McCrae, D. J.—Air spraying against antestia and lacebug in coffee. *Coffee Board Bulletin,* 1958, 23, 94.

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Wallis, J. A. N.—Coffee Seed issued by the Coffee Research Services, *Coffee Board Bulletin*, 1958, 23, 302.

P. A. JONES,
Senior Research Officer.

ANNUAL REPORT OF THE AGRICULTURAL CHEMIST (COFFEE SERVICES), 1958

Following the identification of the magnesium deficiency syndrome in arabica coffee and a preliminary evaluation of the relationship between grass mulching and the incidence of this condition in the field (refer. Magnesium Deficiency in Coffee with Special Reference to Mulching. Emp. J. Exptl. Agric. 1958, *26*, 259), much of the work during 1958 has been directed towards further detailed examination of this problem. It has been shown that regular mulching of the coffee, particularly with Napier grass, grossly exaggerates the incidence of this condition because of the heavy and unbalanced additions of potassium to the soil during decomposition of the mulch.

Particular emphasis has been placed on determining the potassium content of Napier grass (the most common mulch grass material used in Kenya coffee) and of newer potential grasses which may be found suitable for growing as mulch grass crops. Further, exchangeable potassium and magnesium analysis of soil samples collected from the trials on this Station and from commercial estates, have been undertaken with the co-operation of the Scott Laboratories soil analysis organization. Numerous coffee leaf and cherry samples collected from the magnesium fertilizer trials put down on this Station have also been analysed for their potassium and magnesium contents.

Potassium Content of Mulch Grasses

After the long rains 1958, mature Napier grasses and other potential mulch grass species, were cut in preparation for a mulch persistence trial under field conditions. Samples were collected and analysed for their potassium content. In Table I the values for potassium are shown alongside a calculated annual potassium addition per acre following total decomposition of the mulch at the end of a year or less in the field. (The calculation is based on an addition of dry matter per acre of 10 tons; refer. A.R. Dept. Agric. Kenya, 1954, Part II, 126.)

Table I

Species, etc. of mulch grass	% K in Dry Matter	lb. K per acre per annum
Napier grass (*Penn. purpureum* K. Schum.)—		
(*a*) Local hairy	5·98	1,340
(*b*) Hairless (Uganda S.4)	3·41	764
(*c*) Cameroons Selection	3·04	681
Panicum maximum ex. Mackinnon Rd.	2·25	504
Hyparrhenia sp. (S.A.L. 11–4 Selection)	1·52	340
Cymbopogon afronardus	1·14	255
Panicum coloratum (sensulatum)	0·73	164

Other things being equal, i.e. yield of dry matter and/or effective soil cover per acre of mulch grass crop and persistence as a mulch in the coffee, the value of each of these grasses as a coffee mulch increases as the potassium content decreases. This is because a large number of the Kenya coffee soils and the Kikuyu red and dark red loam soils in particular, contain a liberal supply of available potassium whereas the exchangeable magnesium level is only adequate or less than adequate in times of heavy cropping and peak demand by the tree.

Soil Analysis

During the year a number of chemical analyses of coffee soils have been carried out on samples from mulch and magnesium fertilizer trials on this Station and from commercial coffee plantings. Although it is too early to pass any definite comment it does seem that the exchangeable potassium to magnesium ratio in the red coffee topsoils ($HCl - H_2SO_4$ extraction) is of the order of about 2.5-3.0 : 1. It also appears that, where sampling has been possible over an area or field with and without a history of regular mulch grass application for a period of 3-5 years prior to sampling, then the potassium to magnesium ratio becomes even narrower; whilst the regular application of cattle manure raises the exchangeable magnesium status of the soil, it also increases substantially the exchangeable potassium level.

Coffee Leaf Analysis

Leaf samples (4th leaf pair from bearing tertiaries) were collected in one of the magnesium fertilizer trials at the end of the Long Rains period when the coffee had flowered, set its crop and completed its growth flush and in July when the weather was dull and the trees were carrying a large crop in the latter stages of maturation. The trees were old, mature single stem and this was the first year of the trial; no mulch had been applied in this area before the commencement of this trial. Leaf potassium, calcium and magnesium variations were not related significantly to the fertilizer treatments but there was a marked and significant decrease of potassium and magnesium between the two sampling dates, and a significant increase of leaf calcium. Leaf potassium and magnesium were withdrawn to the maturing crop whereas the increase in the mean calcium figure is consistent with the normal accumulation in maturing leaf in the absence of any appreciable growth. Following repeated Napier grass mulch applications and consequent breakdown, in future years changes in this pattern are expected.

These results may be contrasted with analyses made on leaf samples of a similar type collected from a field that had been mulched with Napier grass for 10 years prior to sampling. The times of sampling were the same as before but the coffee is multi-stem and at the commencement of a new pruning cycle. It carried a reasonable crop but also made some growth during the earlier stages of crop maturation. Thus, the mean leaf potassium value fell between May and July, 1958, the mean leaf magnesium value remained almost constant and the mean leaf calcium value decreased. (*See* Table II.)

In this same trial the treatments sampled provided a contrast between mulched coffee with and without the addition of magnesium fertilizer. The mean leaf values for this comparison are summarized in Table II.

Table II—Overall Changes in Leaf Potassium, Calcium and Magnesium with Sampling Time (4th Leaf Pair on Bearing Primaries)

Sampling Date		Treatments	(Means of 7)	Means (of 14)
		No Mg.	*+ Mg.*	
5th May, 1958	K	2·37	2·39	2·38
	Ca	1·19	1·07	1·13
	Mg	0·28	0·25	0·26
21st July, 1958	K	1·89	1·99	1·94
	Ca	0·76	0·75	0·75
	Mg	0·25	0·29	0·27
Means (of 14)	K	2·13	2·19	
	Ca	0·97	0·91	
	Mg	0·26	0·27	

On 5th May, during the main rains, the trees were in an active growth period and were carrying the early immature crop. On 21st July the weather was dry, growth had ceased and the crop was maturing rapidly.

There is a suggestion that the application of magnesium fertilizer has not only maintained the leaf magnesium level in the later stages of crop maturation, but has led to an increase. If this is a consistent effect it is a step in the right direction.

Coffee Cherry Analysis

Analysis of coffee cherry was carried out to detect any change in magnesium content in relation to magnesium fertilizer application.

Results from one mulch ± magnesium fertilizer trial (Block 6 Mulch Trial) are summarized for potassium, calcium and magnesium in Table III. The cherry was picked red ripe in the middle of the crop season.

Table III—Potassium, Calcium and Magnesium Content of Ripe Coffee Cherry (% in Dry Matter)

Treatments	Element	No Mg.	+ Mg.	Means
(1)	K	1·82 (9)	1·87 (10)	1·84
	Ca	0·25 (1·0)	0·27 (1·0)	0·26
	Mg	0·11 (0·5)	0·10 (0·5)	0·10
Alternate inter-row mulch ..	K	1·82 (17)	1·86 (20)	1·84
	Ca	0·23 (2·0)	0·23 (2·5)	0·23
	Mg	0·11 (1·0)	0·11 (1·2)	0·11
All inter-row mulch	K	2·00 (33)	2·03 (42)	2·01
	Ca	0·19 (3·0)	0·19 (4·0)	0·19
	Mg	0·13 (2·0)	0·10 (2·0)	0·11

Notes.—(1) Napier grass mulch applied pre-long rains annually for the past 10 years.
(2) Figures in brackets are pounds of element per acre (10 ft. x 10 ft. square tree spacing).

In the absence of mulch the magnesium fertilizer has had no apparent effect on the plant nutrients removed in a light crop, nor is there yet a suggestion that, despite increased yields with heavier mulch application, the magnesium fertilizer is resulting in a higher magnesium content of the cherry. Two small magnesium fertilizer applications had been applied prior to sampling but visible magnesium deficiency was present in the older leaves from early May.

It is noticeable that the heavier (all inter-row) mulch treatment has increased the potassium content of the coffee cherry very markedly and, considered together with the increased yields, has resulted in a large increase in the removal of potassium from the area.

J. B. D. ROBINSON,
Agricultural Chemist (Coffee Services).

ANNUAL REPORT OF THE ENTOMOLOGIST (COFFEE SERVICES) 1958

Leaf miner (*Leucoptera meyricki* Ghes. and *L. caffeina* Washb.) attacks were widespread and severe, especially in the latter half of the year. By the end of December, however, the parasite complex was generally in control in all areas except Upper Kiambu. Malathion was used to control adult moths, Parathion or Diazinon to control the larvae in the mines. In trials to find a new larvicide which is cheaper than Diazinon and safer than Parathion, Rogor and the Murphy insecticides M.C.7 and M.C.47 showed some promise, but further tests are required. Metasystox and Phosphamidon were disappointing. A spray containing 0.01 per cent pyrethrins killed *L. meyricki* eggs in the laboratory and further work on this line, in co-operation with the Pyrethrum Board of Kenya, was initiated. In a survey in the last quarter of the year at Ruiru, leaf miner damage was shown to be the most important cause of premature leaf fall. In unshaded, somewhat droughted coffee, a single small mine was sufficient to cause abscission.

The tip tem borer *Eucosma nereidopa* Meyr., caused serious damage to suckers on estates in Upper Kiambu which were in the early stages of a multiple stem-pruning cycle. Biological studies have shown that the points in the life history of this pest where it is most susceptible to sprays are—

(*a*) the adult moth, which spends daylight hours chiefly on the trunks of shade and coffee trees;

(*b*) the mature caterpillar which leaves the suckers to pupate on the coffee tree trunks.

Laboratory work was directed to finding suitable persistent insecticides to spray on to the bark to kill either or both of these stages. A number of insecticides show promise and field trials will begin early in 1959.

The berry moth, *Thliptoceras octoguttale* Feld., caused severe damage on estates in the Makuyu-Thika area. Effective control probably depends on spraying when the berries are in the pin-head stage. No attack was reported, however, until destruction of the berry clusters was nearly complete. A trial of 11 insecticides was put down at Makuyu.

Leaf-eating caterpillars were generally less troublesome than in 1957, the skeletonizer, *Epiplema dohertyi* Warr., causing most damage. Lead arsenate is recommended for controlling these pests.

Field trials with various pyrethrum formulations against antestia bugs, *Antestiopsis* spp., gave disappointing results despite the fact that the concentration of pyrethrins used was much greater than is necessary to kill antestia in the laboratory. Experiments designed to throw some light on this discrepancy were started at the end of the year. A test spraying of Malathion by aircraft proved successful. The results obtained and recommendations regarding concentrations were published in the Coffee Board Bulletin of April, 1958.

The lace bug, *Habrochila ghesquierei* Schout., had extended its range to Makuyu and Thika by the end of the year. Some planters found it necessary to spray Malathion or Parathion, but on most estates the mirid predator, *Stethoconus* sp., kept the pest in check.

There were a number of severe attacks of the mealybug, *Planococcus kenyae* (Le Pelley), in the Makuyu area despite the absence of attendant ants. Spot spraying the suckers with Diazinon gave reasonably good control. A few adults of the parasite *Allotropa* sp. were recovered from some Uganda mealybug material. Despite careful treatment, however, they could not be induced to reproduce in the insectary.

Heavy infestations of the brown scale, *Saissetia coffeae,* and the white waxy scale, *Ceroplastes luteolus* De Lotto, occurred on some estates. Fortunately, these scales cause far less damage than an equal number of green scales (*Coccus* spp.). On most plantations the infestation was cleared up by parasites and predators without the trees receiving more than a temporary setback. None of the sprays used killed anything except the smaller nymphs. The bark scale, *Asterolecanium coffeae* Newst., appears to be increasing in severity in low altitude coffee. Five per cent tar oil gave 100 per cent kill of eggs in the laboratory but was very disappointing when tried in the field.

The control measures devised in Tanganyika, namely spraying 18 in. of the trunk with $\frac{1}{2}$ per cent Dieldrin, which have been proved effective in Kenya, were used in a campaign for the control of the white borer, *Anthores leuconotus* Pasc., in the Makuyu-Mitubiri area. All trees more than three years old were treated in March and again in October.

Distortion of young leaves and the formation of corky patches in their undersides is usually attributed to mite damage since the symptoms resemble those described by Tapley on Tanganyika coffee (*E. Afr. agric. J.* (1953), *18,* 191-192). The only phytophagous mite found to date, in any numbers, on Kenya coffee is a red phytoptipalpid, probably *Brevipalpus phoenicis* (Geijskes). This species was caged in large numbers on leaves of various ages but no distortion or suberization resulted.

1958 was the first full year in which an Entomological Field Officer was available on demand to give advice to planters. He made 104 advisory visits of which 26 were concerned with lace bug and 17 with leaf miner. During March and October he acted as Inspector for the white borer campaigns.

Much assistance was received from the Commonwealth Institute of Entomology in the identification of insects, and this is gratefully acknowledged. Mr. G. de Lotto identified scale insects and mealybugs. As usual, many growers permitted experiments to be done on various pests on their estates during the year. Their co-operation is essential and much appreciated.

T. J. CROWE,
Entomologist.

ANNUAL REPORT OF THE PLANT PATHOLOGIST/ PHYSIOLOGIST COFFEE SERVICES, 1958

Physiology

Growth Recording

Scott Agricultural Laboratories.—The July peak of growth which was so marked in 1957, was completely absent in 1958 and there was a reversion to the usual March and October maxima with the multiple stem ahead of the single stem. There was only a negligible difference between the growth of the cropping and stripped trees.

Coffee Research Station.—During the whole year there was a marked uniformity of growth throughout all treatments except that the shaded trees exceeded the unshaded trees in the March maximum; growth of multiple-stem trees was slightly ahead of the single-stem at all times.

The growth response to the Short Rains was delayed in all treatments until November, with the multiple-stem the first to show enhanced growth. Due to the high rainfall, very little irrigation was needed, so that there was no marked advantage to the watered plots. As in 1957, the crop on the single-stem trees was far in excess of the yield of the multiple-stem in all treatments; this was especially so in shaded plots where the cycles are completed so quickly that suckers have to be brought up every two years and the yield is therefore low.

Gibberellic Acid

A small trial was arranged to examine the effect of spraying branches on mature trees with gibberellic acid. A concentration of 100 p.p.m. at the rate of half-pint per tree was applied by a hand sprayer first on 23rd April, 1958. In each block was a control and the other plots received, respectively, one, two and four applications of gibberellic acid at fortnightly intervals.

Growth was recorded at two-weekly intervals for three months on four branches of each tree. As the unsprayed control trees achieved more growth than the treated ones, except towards the end of the period when all were slowing down, it seemed that the gibberellic acid had no effect in these conditions.

Pathology

Leaf Rust

As 1958 was another year of high rainfall, rust infection was severe in most areas. Where anti-rust schedules of fungicide spraying were effectively practised, infection was markedly reduced.

There are now well-tested collection of coffee varieties which react differentially to the strains of *Hemileia vastatrix* endemic in Kenya. Race II is found in all districts of the Colony, but Race I, to which the Kent varieties of coffee are susceptible, has so far been recorded only from Taita, Meru, Makuyu and Ruiru. In spite of repeated tests of rust from the same source, Race VII, reported by Dr. d'Oliveira from material found in Yabe, South Nyanza, has not been isolated.

Clones and seedlings of Ethiopian origin were received from Dr. d'Oliveira. These are reputed to be immune to all Kenya strains of Hemileia and will be available as soon as they are released from quarantine. It remains to be seen if the Ethiopian varieties and those of Indian origin will thrive and prove economic under Kenya conditions.

Spores of Races I and II of *Hemileia vastatrix* have been germinated in "hanging drops" under many differing conditions, from which the following conclusions were derived:—

Exposure to strong sunlight kills spores in 48 hours or less. The usual period during which spores remain viable is between three and four weeks. Complete darkness is not a necessity—subdued light is efficacious for both storage and germination. This could become an important factor where coffee is heavily shaded.

An Experiment to Test the Time of Application of Sprays.—The results of this experiment showed that control of rust exerted by each spray application lasted about four months, after which there was a sharp decline in effect. As this timing appeared to remain constant whether a dry or wet period supervened, it is proposed to initiate an experiment spraying at three-monthly intervals, of which one shall be the anti-leaf-fall application in May, the timing of which has been established by previous tests.

Sprays of lower concentrations are less effective in that they lose their efficacy more quickly and allow the inoculum to build up to higher levels in the period between sprays.

An Experiment to Compare the Value of Seven Fungicides.—Three blocks, each consisting of eight lines of 20 trees, were sprayed with seven different fungicides leaving unsprayed control lines. A year's programme of spraying, including the anti-Hemileia and anti-leaf-fall applications, began with the pre-short rains spray in October. Monthly rust counts are being maintained so that the level of control can be assessed throughout the year.

The fungicides used include Burgundy and Perenox as standards, an oxychloride, Oleocuivre, 40 per cent copper in a mineral oil, a "colloidal copper" and an organic compound—all applied at recommended concentrations.

W. NICHOLLS (MRS.),
Laboratory Technologist,
for Plant Pathologist/Physiologist.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (INVESTIGATIONS)—COFFEE SERVICES

Machine Spray Trial I

Two tractor-drawn sprayers have been compared for applying a copper spray in each May to reduce leaf-fall in the subsequent three months. When the trial started in 1954, the Drake and Fletcher Quadrex "S" was selected as a high volume sprayer to compare with the recently developed "Agro" of Ransomes, Sims and Jefferies which used an airblast to assist the spray. The treatments, which were applied in each of the years 1954-1957 inclusive, are summarized in Table I.

TABLE I—MACHINE SPRAY TRAIL I—YIELD SUMMARY, 1955–1958

(Mean annual yields in cwt. clean coffee per acre)

Lb. of 50% copper formulation/100 galls.	Gallons per acre	Sprayer	Mean Yields 1955–1958
Nil	—	—	10·93
6·8	30	Agro Airblast	12·06
6·8	60	Agro Airblast	12·01
13·6	30	Agro Airblast	12·66
13·6	60	Agro Airblast	12·69
6·8	120	Quadrex "S"	13·01
C. of V. %			3·84
Least Significant difference—			
p = 0·05			0·71
p = 0·01			0·98
p = 0·001			1·35

There was no significant difference between treatment yields in 1958, but the mean annual yields for the four seasons, 1955-1958, reveal a number of significant effects. All the spray treatments have succeeded in raising the mean annual yield by between 1 and 2 cwt. of clean coffee per acre. 120 gallons/acre applied with the Quadrex "S" produced a significantly greater yield increase than that recorded for the "Agro" treatments of 30 or 60 gallons per acre provided that the same concentration of copper has been used. At the higher copper concentration there is no significant difference between the yields produced by the coffee sprayed with 30 or 60 gallons an acre from the "Agro" when compared with the Quadrex "S" sprayer applying 120 gallons an acre of the spray with the lower copper content.

Machine Spray Trial II

In this trial two air-assisted sprayers are compared as machines to apply a copper spray to reduce premature leaf-fall and thus to increase the subsequent yield of coffee. The first treatments were applied in May, 1956, and the first crop was recorded in 1957 when yields were low, and no treatment had any apparent effect on the weight of clean coffee produced. In 1958 a good crop was picked from all plots and, as may be seen in Table II, all spray treatments increased the yield of coffee significantly.

TABLE II—MACHINE SPRAY TRIAL II—YIELD SUMMARY, 1957–1958

(*Mean annual yield in cwt. clean coffee per acre*)

Lb. 50% Copper formulation/100 gall.	Gallons per acre	Sprayer	Yields 1958	Mean Yields 1957–58
Nil	—	—	8·98	7·12
6·8	60	"Agro Airblast"	11·30	8·19
6·8	10	"Micron Meg"	12·44	8·64
13·6	10	"Micron Meg"	13·07	9·91
34·0	10	"Micron Meg"	14·47	10·46
C. of V. %			12·03	9·36
Least Significant difference—				
p = 0·05			2·23	1·28
p = 0·01			3·14	1·80
p = 0·001			4·43	2·54

A notable feature of the 1958 yields, and thus of the mean annual yields for 1957 and 1958, is the fact that the higher the concentration of copper spray employed the higher is the yield of coffee. Hitherto the concentration of 6.8 lb. of a 50 per cent copper formulation in 100 gallons of water has been found to be the optimum strength for spraying to reduce leaf fall and it is interesting to note that at this strength 10 gallons/acre applied with a "Micron Meg" sprayer has been as effective as 60 gallons per acre applied with an "Agro Airblast" sprayer. No comparison between sprayers is possible at the higher concentrations of copper.

Makuyu Spray Trial

This trial was begun in 1954 with the object of determining the best time to spray with copper to reduce premature leaf fall. Throughout this trial the spray concentration used has been equivalent to mixing 6.8 lb. of a 50 per cent copper formulation in 100 gallons of water. The spray volume applied per tree has been either 1 pint or 1½ pints depending on the average size of the tree in the experimental area.

TABLE III—MAKUYU SPRAY TRAIL—YIELD SUMMARY, 1955–1958

(*Mean annual yields in cwt. clean coffee per acre*)

TIME OF SPRAYING	Yields 1958	Mean Yields 1955–1958
Nil	10·36	6·64
Early Long Rains (early April)	10·33	8·25
Late Long Rains (late June)	12·11	8·71
Early Short Rains (early November)	9·50	7·76
C. of V. %	14·11	7·86
Least significant difference—		
p = 0·05	Not	0·98
p = 0·01	significant	1·41
p = 0·001		2·07

There was no statistically significant effect of treatments in 1958 but it may be seen in Table III that a number of substantial differences are detectable in the mean yields for the seasons, 1955-58. The best time to spray is evidently at the end of the Long Rains; this treatment has yielded over 2 cwt. of clean coffee a year more than the unsprayed treatment. The early Short Rains treatment has succeeded in raising the yield significantly but to a lesser extent than have either the early or late Long Rains sprays.

Urea Spray Trial

The effect on coffee yield of foliar sprays containing various concentrations of urea has been compared with urea applied around the base of each tree in a pelleted or prilled form. The high volume sprays have been applied with a bucket pump and the low volume sprays were put on with a "Micron Meg" sprayer in 1957 and with a "Motoblo" in 1958. After the 1958 treatments had been applied it was discovered that the urea used included over 7 per cent biuret. This exceptionally high level of impurity led to a considerable amount of leaf scorch on the trees sprayed at a low volume but did not induce much leaf fall. New leaves produced after spraying showed symptoms of biuret toxicity.

TABLE IV—UREA SPRAY TRIAL—YIELD SUMMARY, 1957–1958

(*Mean annual yields in cwt. clean coffee per acre*)

LB. OF UREA PER ACRE	METHOD OF APPLICATION				Means
	Nil	Dry to the Ground	High Volume foliar spray	Low Volume foliar spray	
Nil	7·00 (*a*)				7·00 (*a*)
25			7·55 (*a*)	8·40 (*a*)	7·98 (*b*)
50		8·37 (*a*)	8·49 (*a*)	8·52 (*a*)	8·46 (*c*)
100		8·73 (*a*)	8·53 (*a*)	8·59 (*a*)	8·62 (*c*)
200		9.77 (*a*)			9·77 (*a*)
Means ..	7·00 (*a*)	8·96 (*c*)	8·19 (*c*)	8·50 (*c*)	8·40
C. of V% .. 15·24					
Least significant difference between	(*a*) & (*a*)	(*a*) & (*b*)	(*a*) & (*c*)	(*b*) & (*c*)	(*c*) & (*c*)
p = 0·05 ..	2·19	1·90	1·79	1·42	1·27

In neither 1957 nor 1958 was the overall treatment effect statistically significant (f test), but a closer analysis of groups of treatments shown in Table IV shows that, in general, all the fertilizer treatments have tended to increase the yield of coffee and that method of application has not had much effect on the levels of response.

J. A. N. WALLIS,
Agricultural Officer (*Investigations*).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), COFFEE, AFRICAN DISTRICTS, 1958

Coffee Variety Trials in African Areas

Many of the potential African coffee areas have a climate which is ideal for the Leaf Rust Disease of coffee (*Hemileia vastatrix*). During 1958 many observations were made concerning the ability of various coffee varieties to resist this disease and as a result a considerable amount of valuable information was obtained.

In Nyanza Province at altitudes below 5,400 ft. the ability of coffee to resist *Hemileia vastatrix* is of critical importance. The variety K.7 is outstanding in variety trials in Elgon Nyanza where, despite the existence of Dr. d'Oliveira's Race I of the disease, K.7 trees produce yields of between 6 and 12 cwt. of clean coffee per acre. Although K.7 is not immune to attack by Race I of *Hemileia vastatrix*, the K.7 trees are not attacked as severely as S.L.28, S.L.34, S.L.14, S.L.30, SL.2 and Kapretwa Series A.

A new race of *Hemileia vastatrix* was discovered attacking the variety Kents in the Yabe Variety Trial, South Nyanza District. This was designated by Dr. d'Oliveira as Race VII.

The rust exposure trials planted in 1956 in Taita, Meru and South Nyanza districts were observed for rust resistance. At Taita and Meru, where Races I and II of *Hemileia vastatrix* are known to occur, the Indian varieties S.288 and S.795 showed complete immunity. In South Nyanza where Race II is generally distributed varieties K.7, S.288, S.333 and S.795 all remained free from disease. During 1959 the rust resistance trials will be extended to include five other Indian varieties; information on the crop potential and liquoring quality of the varieties planted in 1956 should be obtained during 1959.

The variety S.L.6 continued to show resistance to *Hemileia* in the Fort Hall District of Central Province. This variety will be planted commercially as an alternative to the variety K.7 in the *Hemileia vastatrix* endemic zones of Central and Nyanza Provinces.

B. HANGER,
Agricultural Officer (Research), Coffee, African Districts.

ANNUAL REPORT OF THE COFFEE BERRY DISEASE RESEARCH UNIT

This proved a very disappointing year for Field Research on Coffee Berry Disease, especially in districts west of the Rift. All comparative fungicide trials failed because of the low incidence of disease, and this, together with the phyto-toxic effects of organo-mercurial sprays, which became evident this year for the first time, made it necessary to recast the programme. The extent and seriousness of the phyto-toxic effects (described by Bock, Robinson and Chamberlain in "Zinc Deficiency induced by Mercury in *Coffee arabica*", Nature Vol. 182, pp. 1607-1608, Dec. 6, 1958) did not become apparent until early in 1958, and the decision to abandon the use of mercurials was not taken until April, by which time the critical sprays had been applied. Consequently any significant results must be attributed to the mercurial sprays, and not to subsequent treatments.

Ten trials of varying design, collectively involving 30 acres, were designed to investigate salient aspects of control. Detailed investigation of the effects of sprays applied during the February-April period showed that the critical period may be short and that, for 1958 sprays applied in early March gave maximum response. Trials in the lower areas (5,400-5,800 ft.) showed that, although some losses due to attack on flowers may sometimes occur, this does not seem to be of frequent occurrence and little response was obtained this year.

In the West Rift, evidence of effective control with Captan was secured, and these trials also showed that Leaf-rust could also be controlled; the effects on spore-production by Hemileia was also marked, the total inoculum produced by a treated plantation being reduced about 500 times. Captan also has a marked beneficial effect on the growth of the three, while the beans are larger and liquoring is improved.

Laboratory work on *Collectotrichum coffeanum* is now almost complete and is being written up, and the first paper of a series is expected to appear in the Transactions of the British Mycological Society. The main effort this year has been an investigation of the reservoir of infection in the maturing bark of the tree. The pathogen does not normally invade either the green epidermis of the young twig or mature bark. The 8-10 internodes between these are, however, always colonized and the inoculum produced on these is of greater importance than the smaller amount normally derived from the berries. Consequently, attention has been directed towards the effect of fungicides on the pathogen in the twigs. Suitable techniques have been worked out and it has been shown that the sprays which are effective in field trials are those which have affected inoculum-production from the twigs. This work is still in progress.

F. J. NUTMAN,
Senior Principal Scientific Officer.

ANNUAL REPORT OF THE GRASSLAND RESEARCH TEAM, 1958

Review of the Year

At Kitale, work on the selection of improved varieties of Rhodes and Molasses grasses which was started over four years ago has now resulted in a number of promising new varieties which are ready for testing under farming conditions. The breeding habits and the variability of the main ley grasses, have been studied to form a sound basis for future plant breeding work. Investigations on ley management have shown that production can be increased by good management and also that the grass clover balance can easily be controlled. The evaluation of leys by means of meat and milk production from identical cattle twins is now making good progress. The main effort of the year has been concentrated on obtaining more information on the problem of soil deficiencies, particularly phosphorus and sulphur, and also certain other elements, and on relating these elements to plant growth.

Seed multiplication has increased in scope, and is providing material for experimental work and for farmers. The seed certification scheme has now made a start and farmers are beginning to grow grass and clover seed commercially, on a larger scale.

At the Molo substation, at 9,000 ft., development work has been almost completed now. A useful number of species has been tested for the high country, and work on soil deficiencies is progressing, with a view to improving soil fertility and increasing production.

A survey of the main ranching areas has now been completed, which gives a useful picture of the problems and condition of those areas.

Work at Katumani and in the Marigat area on bush control and other problems has made useful progress.

Kitale Grassland Research Station

Weather and Rainfall

The rainfall for the year, compared with the two previous years, is given below. It will be observed that the rainfall in January, February and March is unusually high, as these are normally months of relatively dry weather. The month of April, when planting normally takes place, was particularly dry, and June, regarded usually as a time for dry spells, produced over 10 in. More rain than usual seemed to come as heavy storms during the season.

Rainfall Table

Month	1958		1957		1956	
	Rainfall inches	No. of wet days	Rainfall inches	No. of wet days	Rainfall inches	No. of wet days
January	3·01	4	0·94	7	2·12	9
February	4·40	8	0·15	3	3·10	6
March	5·06	5	3·19	12	2·56	7
April	2·46	13	6·75	22	5·75	20
May	4·77	14	9·24	20	6·85	21
June	10·60	20	4·66	18	2·70	18
July	2·82	18	4·18	12	4·72	20
August	7·84	19	5·96	19	7·50	21
September ..	4·35	13	1·24	9	4·46	18
October	4·85	16	1·22	10	4·73	17
November ..	0·80	6	2·35	14	0·56	3
December	0·92	6	1·77	7	0·75	6
Totals ..	51·88	142	41·65	153	45·80	166

Plant Introduction and Nursery Work

In the plant introduction and nursery work 174 samples of seeds and roots were obtained from various parts of Kenya and from Britain, France, U.S.A., Malaya, Algeria, South Africa, Ceylon, Senegal, and the Belgian Congo. Amongst the better varieties deserving further trial were the Sabi variety of Guinea grass (*Panicum maximum*) from S. Rhodesia, and also two varieties of Guinea grass from Kenya, the Ixopo variety of Rhodes grass (*Chloris gayana*) from South Africa and others from Kenya and Senegal, two varieties of Red clover (*Trifolium pratense*), two varieties of Velvet Beans (*Stizolobium*), and a variety of Berseem clover (*Trifolium alexandrinum*) from southern Europe. *Andropogon gayanus*, a West-African grass, also seemed promising.

Preliminary Grazing Trials

Preliminary grazing trials are the next stage after the nursery in the evaluation of pasture plants. One trial which was completed contained 11 varieties of Molasses grass, 12 varieties of Star grass (*Cynodon*), 12 varieties of Rhodes grass and a number of other species also. Kitale commercial and Chania River were amongst the best varieties of Molasses grass, and Nzoia, Mbarara, Endebess and Chepararia varieties of Rhodes grass showed good results. Of the various grasses *Pennisetum dowsonii* and *Panicum coloratum* were particularly successful. A more detailed report on the results of this trial is being prepared for publication. In the field trials planted in 1958, varieties of *Setaria sphacelata*, *S. splendida*, and of Red clover are being compared, and also, among others, there are hybrids of *Phalaris* including Ronpha grass and a similar *Phalaris* hybrid from Aberystwyth.

Grass Breeding and Selection

Selection for an improved variety of *Setaria sphacelata* based on "Nandi Setaria"—a variety of *S. sphacelata* from the Nandi District in Kenya—has now reached the stage of last polycross. It is intended that the comparison of the improved strain with the original type will start in 1959.

Progeny tests of *Cenchrus ciliaris* and Molasses grass were completed in 1958. Four generations of six distinct varieties of *Cenchrus ciliaris* were studied. They all bred exactly true to type and each generation produced very uniform progeny though the parent plants had every chance to cross. These findings agree with the results obtained by Snyder, Hernandez and Warmke (in the U.S.A.). The study of Molasses grass progeny, also for four generations, produced results rather similar to those obtained for *Cenchrus*. However, one hybrid plant was found in 1957. There seems to be little or no information in the literature on the breeding habits of Molasses grass. Our results suggest that Molasses grass may be a facultative apomict, with a very low proportion of natural crossing.

Further bagging of Rhodes grass in 1958 supported the results obtained in 1956 which showed that the flowering heads of *Chloris gayana* enclosed in bags produce only a fraction of the amount of seed developed under free flowering. This again indicates that Rhodes grass is essentially a cross-fertilized species. The uniformity tests of *Chloris gayana* carried out at Kitale in 1957 and 1958 showed that varieties of this species are not uniform even when purity of seed is maintained by isolation. *Chloris gayana* is a creeping, stoloniferous grass, and in ordinary stands the variability inside the strain can hardly be noticed. However, in plots, each of which was grown from a single seed, the variation of forms in a strain or variety is very noticeable and even more so if the parent plants had a chance to cross with other types or varieties. The Endebess, Mbarara, Nzoia and Mpwapwa varieties were tested for uniformity, and all of them showed

a remarkable amount of variability. Some valuable characters, including resistance to certain diseases, varied considerably and this suggests that there is a possibility of improvement, even in our best varieties.

Ley Pasture Plants and Ley Management

Further useful information has been obtained during the season on yield, quality, and overall performance of general purpose and dry or late season pastures.

A preliminary study of the influence of Kenya white clover in leys, has been completed after four seasons. The results have shown that the application of superphosphate and gypsum has resulted in a vigorous growth of clover, and has substantially raised both the yield and quality of the pasture.

A further experiment, in which four legumes are being compared in mixture with Nzoia Rhodes grass, has now run for three seasons. The following table illustrates the beneficial effect of the inclusion of legumes in a ley on the yield of dry matter.

Table I—Dry Matter Yields of Grass + Legumes, 1956–57–58

	1956	1957	1958
Nzoia Rhodes grass with:—			
Kenya white clover (*Trifolium semipilosum*) ..	17·6	30·2	35·3
Louisiana white clover	17·3	30·1	35·5
Lucerne	17·7	30·9	37·1
Rueppells clover (an indigenous annual) ..	17·4	25·9	24·3
Control, grass alone	17·2	23·7	22·6
S.E. of difference between means	0·9	0·9	1·4

After the establishment year the rhodes grass with two perennial white clovers and with lucerne have all yielded significantly more than the control. The higher yields of these mixtures have been due to the additional weight of legumes rather than to a stronger growth of grass, so far.

For the purpose of herbage production in the dry season, the yields of a number of species are being compared under a clipping treatment and managed as for late season grazing. The management which is adopted at Kitale for late season leys is to graze the first flush, rest for 3-3½ months during the main growing season, graze and mow some weeks before the end of the wet weather, then keep the resulting growth as a standing reserve for use late in the season when green grazing is at a premium. The following figures are expressed in cwt. per acre of leaf dry matter during the first dry season (1957-58). The cuts were taken in January and March. Sigor Guinea 43, Molasses grass in 3 ft. rows 41, Molasses grass in 6 ft. rows 38, Slender Guinea 33, Gold Coast Elephant grass 31, Nzoia Rhodes in 6 ft. rows 26, Giant Setaria (*S. splendida*) 25, Nzoia Rhodes in 3 ft. rows 20, Columbus grass (*Sorghum almum*) 18. Sigor Guinea grass and Molasses grass were superior to the other species during the first season.

It has sometimes been thought that the management of a pasture for dry season grazing on the lines suggested above may result in an overall loss of dry matter yield compared with that obtained from the standard management used for general purpose leys, i.e., on and off grazing during the normal rainy season, with haying or ensiling of surplus growth. A comparison of the first full season's yields from similar plots managed in these two ways showed that there was no loss of dry matter with either Molasses or Slender Guinea, but rather the reverse, where these two grasses were managed to provide a dry weather reserve.

The amounts of dry matter (leaf only) per acre were, Molasses grass, rainy season 60 cwt., dry season 74, Slender Guinea, rainy season 46 and dry season 51 cwt.

The effect of legumes on both the quantity and quality of a standing dry weather reserve is also being examined. The most satisfactory species which have been found so far in this particular role are: *Glycine javanica,* perennial *Dolichos sp.* near *D. lablab,* and *Desmodium uncinatum.* The two former are twiners which would probably be grown in the same rows as the grass, while the latter is a semi-prostrate perennial herb which can be sown between the rows of drilled grasses. With this object in view, five legumes are being compared in mixture with Slender Guinea grass under dry season grazing management, and the following yields have been obtained during two seasons in cuts taken from November to March.

TABLE II—THE DRY WEATHER YIELD OF SLENDER GUINEA + LEGUMES
(*Cwt. per acre of leaf dry matter*)

	1956–57 Dry Season	1957–58 Dry Season
Slender Guinea with:—		
Perennial Dolichos	43·5	19·8
Glycine javanica K.50101	33·5	16·6
Glycine javanica K.51112	31·7	16·7
Lucerne	37·1	14·1
Rueppells clover (*T. reuppellianum*)	40·2	18·0
Control, grass alone	46·1	13·3
S.E. of difference between means	3·1	1·3

A point of interest in these figures is that while grass alone gave the highest yield in the establishment year, it gave the lowest yield in the second dry season.

Not only were the yields of the mixed grass plus legume plots higher than the yield of the control plot in the second dry season, but the quality of the herbage, as indicated by the digestible crude protein, was also higher. The percentage of digestible crude protein in the dry matter, analysed from a cut taken in early March, 1958, was as follows:—

Glycine (K.50101) mixture 6.1 per cent, perennial Dolichos mixture 5.7 per cent, *Glycine* (K.51112) mixture 5.7 per cent, Lucerne mixture 4.9 per cent, Rueppells clover mixture 4.5 per cent; control, grass alone 3.7 per cent.

A comparison of six Elephant grass strains for late season grazing is also in progress. The herbage was all harvested in the dry season.

The French Cameroons strain appears to be particularly efficient as a producer of leaf during the drier months. The Gold Coast strain was the higher yielder during the rains, its total season's production (wet plus dry weather) being 65 cwt. of dry leaf compared with 54 cwt. for the French Cameroons strain.

Observations on the management of general purpose grazing leys mentioned in our 1957 annual report, have now been concluded. The results, have shown that it is possible to control the proportions of Kenya white clover and grass in a mixed sward. Clover is encouraged by close mowing and frequent grazing with cattle, and is retarded by the reverse treatment. The relative importance of grazing and mowing is not yet known. In this trial Nandi *Setaria* has persisted better than the other species under close grazing, with Slender Guinea as next

best. Nzoia Rhodes virtually disappeared after the first year, and Molasses grass had largely disappeared in all treatments by the end of the fourth season, except where a hay cut had been taken from the first flush annually. Lucerne persisted quite well for four years, especially where the pasture had been grazed at infrequent intervals and the residues mown off after each grazing.

Investigations of Phosphorus, Sulphur and Other Deficiencies

The experiments outlined here are intended to shed further light on the phosphorus and sulphur requirements of herbage plants in general and of legumes in particular. Some work has also been done on the possible calcium and magnesium requirements of lucerne and also on the possible trace element requirements of Kenya white clover (*Trifolium semipilosum*), Rueppells clover, and Lucerne, particularly in respect of zinc and boron. The object of this work is to ascertain and then correct any soil mineral deficiencies, so that the fertility of the soil can be improved and better yields then obtained from crops and grassland. Reactions to sulphur, in the form of gypsum, by lucerne have on occasions been difficult to explain owing to their apparent lack of consistency. The general impression gained so far is that clover and lucerne frequently give no response in the first year, but usually begin to do so in the second year. A grass-clover mixture also seems to be more responsive than one of clover or lucerne alone, and in the second and third years it also seems to respond more readily to applications of gypsum. The previous cropping and fertilizer treatments are also important and affect the responses obtained in field experiments. Factors such as soil heterogeneity on the experimental site, and the experimental design itself, have often made the difference between getting or not getting a significant result. Different species also vary in their reactions. Lucerne and Kenya white clover so far seem to be the most sensitive, especially when grown with grass, but grass alone barely responds and has not yet given a significant result, and maize has given no visible response at all to date. Russian comfrey has, however, given a significant response to gypsum once. Rueppells clover did not respond at all to gypsum this season. This species also did not show up sulphur shortage in the soil in a pot test carried out by the Soil Chemist, whereas tomato plants usually show it well in pot tests with our soil. Experience would therefore seem to indicate that in doing field experiments involving sulphur, the crop used is a matter of importance, to enable the deficiency to show up if and where it exists. The age of the plants used also seems to affect the response.

So far, no yield responses have been obtained from arable crops such as maize and wheat, although the latter was only tested on an observation plot, but maize was tested in a large split plot experiment. Another point of interest is that gypsum seems to give a smaller response than a mixture of calcium carbonate and sulphur in which the same amounts of Ca and S are supplied. It may be that the sulphur is more readily available in this form. Whether the value of the calcium is merely in neutralizing acidity from the sulphur, or is necessary as an additional nutrient, or helps the nitrogen fixing bacteria, is still unknown. It may be that magnesium carbonate or potassium carbonate might equally well neutralize the acidity from the sulphur and help to bring about a substantial response. This has not been tested yet.

In an experiment to test the effect of phosphate, gypsum, magnesium and boron combinations on Kenya white clover, the yields in cwt. of dry matter per acre were: P, 30.4; P + S, 34.5; P + S + Mg. 33.0; P + S + Mg. + B, 37.7; mean yield 33.9, standard error 1.61, and L.S.D. at 5 per cent = 5.17. The P + S + Mg + B treatment comes out significantly better than phosphate alone in this experiment.

In a similar experiment with lucerne, the following yields as cwt. of dry matter per acre were obtained: control 11.9, P, 14.2; S, 13.9; P + S, 17.1; P + S + Mg, 21.3; P + S + Mg + B, 19.7; standard error = 1.6, L.S.D. at 5 per cent = 4.83, and L.S.D. at 1 per cent = 6.67. The P + S + Mg and P + S + Mg + B treatments attain significance at the 1 per cent level and the P + S treatment at 5 per cent.

The indications here, together with those from many observation plots, show the need for further investigations on magnesium, boron and sulphur.

In an investigation with lucerne on the effects of gypsum, compared with equivalent amounts of calcium (as $CaCO_3$), and pure sulphur, singly and in combination, the $CaCo_3$ + S treatment was better than the control, (no Ca or S, but basic P only, as in all treatments), at the 1 per cent level, and better than $CaCO_3$ or S alone at the 5 per cent level. Gypsum did not achieve a significant response, neither did $CaCO_3$ alone, or pure sulphur.

An experiment was carried out to compare the effect of various phosphatic fertilizers, with and without gypsum, on Rhodes grass and Kenya white clover. Urea was included, except in the ammonium phosphate treatments, to balance up the nitrogen in the latter. The design was an incomplete balanced block with 13 treatments and 4 replications. The yields given are those for the two years for which the experiment has run, and comprise the grass plus clover.

YIELDS AND RATES PER ACRE PER ANNUM OF TREATMENTS SHOWN

FERTILISER APPLIED	RATES PER ACRE IN LB.			Total D.M. cwt./acre (2 seasons)
	Phosphate	Gypsum	Urea	
Triple superphosphate + gypsum ..	100	168	43½	114
Hyperphosphate + gypsum ..	600	168	43½	112
Di-ammonium phosphate + gypsum	100	168	—	108
Soda Phosphate + gypsum ..	271	168	43½	106
Gypsum alone	Nil	168	43½	101
Triple superphosphate + gypsum ..	50	168	43½	100
Uganda Rock Phosphate + gypsum	600	168	43½	98
Basic Slag + gypsum	306	168	43½	98
Di-ammonium phosphate	100	—	—	97
Triple superphosphate	100	—	43½	93
Soda Phosphate	271	—	43½	88
Basic Slag	306	—	43½	86
Control	Nil	—	43½	64

Difference required for significance between two treatment yields
at 5% level = 14·06 cwt.
1% level = 19·96 cwt.
0·1% level = 25·28 cwt.
S.E. = 6·85

It is interesting to observe that the control yield, with urea alone, is the lowest and that triple superphosphate plus gypsum is the best. All yields above 84 are significant at 1 per cent and all above 90 at the 0.1 per cent point over the control. Triple supers at 100 lb. per acre plus gypsum is significantly better than triple supers alone at the 1 per cent point. Gypsum alone is significantly better than control (no P) at 0.1 per cent, which is of considerable interest. This is the first experiment where the Uganda rock phosphate has shown up well on this station, but is probably unique in using this with gypsum and applying it to a grass/clover mixture. Rock phosphate on grass alone has usually been disappointing, producing hardly any response.

In the experiment in which P, S, Mg and B were applied to Kenya white clover, the plots were all split and $ZnSO_4$ was applied to one half. The response, while not large, was consistent enough to give a significant response to the "t" test, thus providing a first indication from field experiments that some plants can benefit by the application of zinc. No responses have yet been obtained from other crops or herbage plants.

In one of the co-operative experiments carried out on a farm in the Cherangani area, where the soil type is similar to that on the Kitale Grassland Station, responses to phosphorus, sulphur and zinc were obtained from Rhodes grass with Kenya white clover. The rates of application per acre were: triple supers 100 lb., gypsum 168 lb., zinc sulphate 15 lb., and borax 15 lb. The treatment combinations and yields in cwt. of D.M. per acre were:—Control, 8.3; P, 18.2; P + S 26.8; P + S + Zn, 32.1; P + S + Zn + B, 27.0; S.E., 1.92, and L.S.D., 5.76. All treatments are significantly better than the control at 1 per cent, while P + S and P + S + Zn + B are better than P at 2 per cent and the P + S + Zn treatment is better than P alone at 1 per cent.

The relative importance of these various elements in the soil of the district is still not known and it will need much more work before it becomes clear which crops might benefit from the elements other than nitrogent and phosphorus. It will also take time to investigate the rates and frequency of application, also the combinations which may possibly be necessary for different crops. The various experiments described above do, however, indicate the possibility of magnesium, zinc and boron shortages of unknown degree, and further evidence regarding sulphur deficiency in the soil comes forth almost every year.

Seed Multiplication and Certification

About 15 acres of new land were broken and planted, bringing the total acreage now under seed production to 50. Grass and legume seeds are being multiplied to produce sufficient material both for trials within the department and Stock seed for the seed certification scheme. The Rhodes grass varieties being grown are:— Nzoia, Mbarara, Endebess, Mpwapwa, Chepararia, and Alego strains, and of other species, Nandi *Setaria;* Slender, Coloured and Sigor Guinea grasses; *Bothriochloa insculpta*, Molasses grass, *Paspalum*, Kenya white clover, Rueppells clover and the Saladina and Pampeana strains of lucerne. Nine common varieties of lawn grasses were also planted in tenth of an acre plots.

The yields of seed from Rhodes grasses planted this year have been moderately good at about 200 lb. an acre as compared with second-year yields of only 90 lb. an acre. This tendency towards higher yields in the first year also seems to occur with the Guinea grasses and second-year Slender Guinea grass has also not yielded well.

A comparison has been made of different methods of harvesting. The reaper-binder was used for many of the grasses, the stooks being left in the field for two to four weeks before being threshed. The resulting seed appears to be good. Clovers have been successfully harvested with a "Rotoscythe" lawn mower, the machine drawing the seed and leaf up into a box. This is then dried, beaten out and winnowed. Unfortunately sand is also drawn into the box and the seed requires more careful cleaning. The "Peppard" Seed Stripper, an American seed-harvesting machine, is inclined to strip all seed heads off instead of only the ripe ones, and therefore requires certain alterations. With beater-bars instead of stripping nails on the drum, and geared down to run more slowly, it may prove very useful for harvesting the *Panicum* species, and *Bothriochloa insculpta*. Bunt

(*Tilletia* sp.) disease has been severe this year on Nandi *Setaria* and the yields have therefore been low. It has not, however, affected the Guinea grasses to any extent. The seed certification scheme has now been in operation for a year. Of the farms that have been visited for field inspection, eight have been passed for certification, the crops being:—Mbarara Rhodes 34 acres, Nzoia Rhodes 35 acres, Nandi *Setaria* 21 acres, Kenya white clover five acres, and Bamenda white clover two acres.

It is suggested that the following varieties should be added to the schedule of species eligible for the seed certification scheme: *Trifolium rueppellianum*, *Panicum maximum* var. *trichoglume*, and *Panicum coloratum*.

Pasture Research Chemist's Report

ACID-FIBRE

The 0.255 N –, N –, 2N –, 3N and 6N – H_2SO_4 fibre content of the feed and of the faeces resulting from the ruminant digestion of Star grass, canna tops, meadow hay and the same meadow hay fed with cassava were determined. The materials were first freed from fats with boiling alcohol-benzene mixture 1:2 by volume, for eight hours and then digested with the appropriate concentration of sulphuric acid for one and a half hours. The crude protein and the true protein associated with the respective acid-fibre residues were determined by conventional methods.

It was found that for each of the feeds and the faeces, the amount of crude protein (c.p.) and of true protein (t.p.) associated with the acid fibre is directly related to the strength of acid used for digestion. For Star grass, the following equations express these relationships:—

Per cent c.p. associated with H_2SO_4 – fibre = 5.24 – 0.599 H_2SO_4 concentration ($1 - r^2 = 0.07$)

Per cent t.p. associated with H_2SO_4 – fibre = 4.70 – 0.533 H_2SO_4 concentration ($1 - r^2 = 0.107$).

It was found also that for each feed used the ratio between the total intake of acid fibre from the feed less the crude protein associated with the acid fibre and the total output of acid fibre from the faeces less the crude protein associated with the acid fibre is a constant, whatever the strength of the acid used for the acid-fibre determination. Similarly, the ratio between the total intake of non-acid fibre from the feed less the crude protein associated with the non-acid fibre and the total output of non-acid fibre from the faeces less the crude protein associated with the non-acid fibre is also a contant. The constants vary, as might be anticipated, with the feed used. It is well known that an estimate of the feed to faeces ratio can be obtained from a knowledge of the crude protein content of the faeces of pasture-fed cattle, and the question that arises now is whether or not an estimate of the feed to faeces ratio might be obtained from a knowledge of say the N – H_2SO_4 fibre content of the faeces of animals at pasture. This notion, however, has first to be tested for both ruminants and non-ruminants under controlled conditions.

A study of N – H_2SO_4 fibre content of lucerne sampled at weekly intervals throughout a growth cycle was made, with the following results:—

(1) The N – H_2SO_4 fibre is directly related to the conventional "crude fibre", as determined by the Fertilizers and Feeding Stuffs Regulations.

(2) The N – H_2SO_4 corrected for the crude protein associated with the acid-fibre is directly related to the conventional crude fibre.

(3) The crude protein associated with the N – H_2SO_4 fibre is directly related to the total crude protein contained in the dry matter of the legume. These results take into account a wide range of crude protein and crude fibre values and they confirm and extend the results reported in the Journal of the Science of Food and Agriculture (Vol. 9, 1958) for roughages in which crude protein values were relatively low and crude fibre values were relatively high.

The Phosphate Requirements of Grazed Star Grass

Two field experiments, one on the E.A.A.F.R.O. farm, Muguga, and one on the Station farm, Kitale, were established in 1956 to study the phosphate requirements of grazed Star grass pasture. In these experiments the treatments are as follows:—

A—No phosphate.

B—Triple superphosphate applied for the first time in 1957 at 30 lb. P_2O_5 per acre. This dressing will be repeated in 1959.

C—Triple superphosphate applied for the first time in 1957 at 60 lb. P_2O_5 per acre.

D—Triple superphosphate applied for the first time in 1956 and repeated in 1958 at 30 lb. P_2O_5 per acre.

E—Triple superphosphate applied in 1956 for establishment at 60 lb. P_2O_5 per acre.

F—No phosphate at Muguga and a starter dose of $7\frac{1}{2}$ lb. P_2O_5 per acre only, at Kitale in 1956.

Plots A, B, C, D and E, received urea at the rate of 23 lb. per acre for establishment and the same amount is applied after each grazing. There are four replications of these treatments in the Muguga experiment and three in the Kitale experiment. The plot size is 1/6 acre and the area harvested for yield data and for herbage consumption is three randomized strips each 5 yd. × 2 yd.

The mean results of the two experiments, now almost at the end of their third year, are given in terms of dry matter yields, percentage composition and yield of nutrients, in Tables I and II below:—

Table I—Muguga Star Grass

(*Mean results from 6 harvests*)

	A	B	C	D	E	F	S.E.
Dry Matter (cwt. per acre) ..	15·0	15·7	20·7	19·9	20·8	9·9	1·93*
P—Per cent	0·114	0·124	0·149	0·129	0·127	0·096	0·006**
P—Yield (lb. p.a.)	2·10	2·55	4·17	3·40	3·34	1·28	0·45*
N—Per cent	2·11	2·13	2·18	2·06	2·04	1·94	0·08
N—Yield (lb. p.a.)	36·7	39·3	54·5	49·3	51·1	22·8	6·07*
Ca—Per cent	0·43	0·41	0·41	0·41	0·43	0·37	0·017
Ca—Yield (lb. p.a.)	7·2	7·1	9·8	9·4	10·2	4·4	1·02*

TABLE II—KITALE STAR GRASS

(*Mean results of* 8 *harvests*)

	A	B	C	D	E	F	S.E.
Dry Matter (cwt. per acre) ..	7·5	9·5	11·8	11·2	12·0	10·6	0·9*
P—Per cent	0·230	0·213	0·243	0·257	0·254	0·216	0·017
P—Yield (lb. p.a.)	1·87	2·32	3·35	3·06	3·38	2·47	0·41
N—Per cent	2·66	2·33	2·23	2·22	2·01	1·76	0·09*
N—Yield (lb. p.a.)	20·2	22·9	26·9	27·0	25·1	20·3	1·65*
Ca—Per cent	0·54	0·53	0·53	0·53	0·54	0·53	0·015
Ca—Yield (lb. p.a.)	4·57	5·75	7·01	6·78	7·28	6·31	0·67

In the E.A.A.F.R.O. experiment the nitrogen and the calcium content of the grass are so far unaffected by the different treatments. Treatment F receives no fertilizers and the phosphorus content of its herbage does not differ significantly from that of treatment A which receives urea only, but it is significantly lower than all the remaining treatments which receive fertilizer phosphorus as well as urea. Treatment F gives yields of dry matter and of nitrogen, phosphorus and calcium that are significantly lower than the corresponding yields from treatments C, D and E which have all received the same amount of fertilizer phosphorus and urea, but that do not differ significantly from the corresponding yields from treatment B which so far has received only half the amount of fertilizer phosphorus but the same amount of fertilizer nitrogen as these latter treatments.

In the Kitale experiment neither the phosphorus nor the calcium content of the Star grass is affected so far by the different treatments but the nitrogen content of the herbage from treatment A, which is the application of urea only, is significantly higher than that from each of the remaining treatments. Treatment A gives a yield of dry matter that is significantly lower than those of treatments C, D, E and F, while treatments A and F give yields of nitrogen that are significantly lower than those of treatments C and D but not of E. Yields of phosphorus and calcium are so far unaffected by the different treatments.

NITROGEN, PHOSPHORUS AND SULPHUR RELATIONSHIPS IN STAR GRASS

In the annual report for 1957, reference is made to an experimental programme for the purpose of studying the changes that occur in the chemical composition of grasses at advancing stages of their maturity, and to the many relationships that had been examined. These included the relationship between "total carbohydrate", i.e., the sum of the "soluble" carbohydrate and the "crude fibre", and crude protein and the relationship between "total carbohydrate" and total phosphorus. The second phase of this programme, namely the determination of gross energy and of sulphur, began during the year under review, using Star grass. This grass had been sampled at weekly intervals between February and July, 1957, during which month the grass was cut back and the sampling of the regrowth began in August and ended in November, 1957. Total sulphur was determined by use of the bomb-calorimeter; precipitation of the sulphur as sulphate was carried out with barium chloride and the sulphate was estimated by titration with magnesium chloride using eriochrome black as indicator, after complexing the sulphate with excess 0.02 Molar disodium ethylene diamine tetra-acetic acid in the presence of 9 N-ammonia.

An initial examination of the results which took into account only the average status of total N, P and S in Star grass during growth hinted at the possibility of sulphur in Kitale soil being in marginal supply, since the percentage of sulphur contained in the crude protein averaged 0.57 as against the value of 0.60 usually quoted. It would appear that if all the N contained in the Star grass

occurs as crude protein, then all the available sulphur would be required for protein formation. When the results were examined in greater detail, however, it became evident that the apparently low percentage of S contained in the crude protein was confined to a group of records which dealt with very early growth at the end of the dry season and the beginning of the rains, i.e. during the period 22nd February to 3rd April, 1957. This group of records was of such an extent that it depressed the average S content of the crude protein to a value which might be associated with a sulphur shortage. This effect did not occur in the grass sampled between 3rd April and the end of May when the average percentage of S in the crude protein was 0.68, nor did it occur in the regrowth material sampled between August and the beginning of October at a time when the August rainfall of 6 in. was followed by a month of relative dryness. During this latter period the percentage of S in the crude protein was 0.76.

Both N/S and P/S interactions in the Star grass can be easily traced, and as might be expected the interaction of all three elements is predominant in the growing plant. This interaction has not so far been observed in mature material, i.e., in material which has passed the heading and flowering stages of growth when, except for an increase in total carbohydrate, much activity ceases.

Molo Grassland Research Station

General

There was less rain than usual, 38 in. being recorded up to December, of which 7 in. fell in February before the planting season. The building up of the Red Poll herd and the Corriedale flock continued. The whole clip averaged 10½ lb. from the ewes which are now being hard culled with the aim of a better carcase and improved fecundity (lambing per cent around 100 at present); the arrival of two New Zealand rams from the Canterbury area should help towards this end.

Development

No development of the Station was possible last year because of lack of funds, so it is pleasing to report that with the development possible this year, the station has become fully fenced and paddocked, the watering points are nearly finished, and a dairy and self-feed silage shed are now being constructed. These will allow far more stock to be carried with benefit to the land and the revenue forthcoming from the Station. The plough-up policy has continued and has now extended to the hill sides, *all* the arable land already being ploughed up for cereals, experiments, grass trials, pyrethrum, wheat plots, or allocated for field-scale grass and legume sowings in 1959.

Experimental

Excluding minor projects, the 25 main experiments on the Station at present will bring to an end the first agronomic phase of the work. Results are being prepared for publication and only a few points can be considered here.

Species and Strains

For the wet lands Yorkshire Fog is already in use to a small extent, and its use may be recommended. The perennial Oat grass (*Arrhenatherum elatior*) shows considerable promise, and S. 170 Tall Fescue can be recommended to take the place of K. 31 fescue which often becomes very stemmy. The Marietta strain of Timothy is the best found so far, but its use must be investigated further. Although flowering strains of perennial ryegrass have been obtained now, the high incidence of rust on the inflorescences precludes any further advance at present.

New cocksfoot strains which showed promise in even seed ripening and resistance to shattering are, unfortunately, less leafy than the usual commercial strains. A useful collection of strains of *Phalaris tuberosa* from Australia has been established, some being extremely vigorous, and now that successful prophylactic measures are available against phalaris staggers there is no reason why this species should not be widely grown in the Highlands, especially on land which is too poor for good ryegrass or cocksfoot growth. For poorer soil and for 18-month leys, Westerwolths ryegrass is already popular and outyielding all other grasses in its first season. The best of the new Westerwolths strains so far is the Mommersteegs variety, which in its first season yields slightly less than the commercial type, but is expected to be more productive in its second season. The Bromar variety of *Bromus marginatus,* which was mentioned last year, has lasted three seasons, while the Kenya *Bromus* dies out in its second year. Bromar seeds poorly, so if it is to replace the Kenya *Bromus,* as it should do, seed will have to be imported from America.

For growing legumes, the typical winter rainfall climate of the high altitudes restricts the number of possible species. The Subterranean clovers—given adequate phosphate—may well yield more in their first season than they do in Australia, but management trials have shown that good regeneration cannot be expected from the Subterranean clovers if they are sown in a dense grass mixture despite the long rainy season, but they do so when sown in pure stands or when drilled in wide rows alternating with the grass. There is now little doubt that establishment should follow the Australian pattern of sowing a very low grass seed rate and obtaining a 90 per cent clover cover in the first year; adequate regeneration is thus ensured for subsequent years. This will be investigated in field trials next season.

Kenya white clover grows locally more slowly than Louisiana or Ladino clovers, and the indications are that in grass mixtures its effects on grass growth will only be apparent in the third year. Lucerne, given adequate phosphate, grows well, and the Du Puits strain is probably the best. A high-altitude strain, "Alta Sierra" from Peru, is also promising and has been sown for observations on seed production. Sulla (*Hedysarum coronarium*) is also promising, while Serradella may be definitely recommended for undersowing in Oats for grazing or early silage, or in the longer strawed barleys to provide aftermath grazing. Selection in *Trifolium burchellianum* var. *johnstonni* from various high altitude districts has started, one acre of single plants having been established for this purpose.

Fertilizers

The effect of phosphates on clover growth confirms earlier grass establishment results, in that under broadcast conditions maximum response occurs at the 4-500 lb. per acre triple superphosphate level. With such applications yields of 26 tons an acre fresh weight can be obtained in three cuts from Bacchus Marsh subclover. Rock phosphate at equivalent rates is relatively ineffective, while Basic Slag yielded about 8 per cent less than triple supers and Kenaf No. 1 gave as good or slightly better responses than triple supers.

Applications of nitrogen fertilizers have caused big increases in grass growth, and the results emphasize how nitrogen-deficient high-altitude leys can become. Urea, though slightly less effective than sulphate of ammonia and N.A.C. (i.e., nitrochalk) is nevertheless cheaper to use; sulphate of ammonia caused appreciable decreases in soil pH in a single year, the decreases being twice those obtained from the other two nitrogenous fertilizers. Heavy applications of N.A.C. reduced the sulphur content of grass by a half, to a level at which the grass responded to

applications of $MgSO_4$. The long-term effects of lime are being studied by the soil chemist's experiment, now in its fifth year. Significant lime effects were obtained on ryegrass growth, especially in the absence of phosphate.

The effects of trace elements have so far shown that on lucerne 30 per cent yield increases from Molybdenum are obtained during establishment, but increases of only 3-5 per cent are obtained per cut during subsequent years, but too big a dressing reduces yields. On Dwalganup Subterranean clover a large Boron × Magnesium positive interaction was obtained despite no effect from either singly, and 20-30 per cent increases from copper and magnesium were also obtained, but only in the presence of high phosphate dressings. On Mount Barker Subterranean clover highly significant molybdenum, and molybdenum × zinc interactions were obtained in the first year; in the second year similar results were obtained but they were smaller and did not reach the level for significance. Trials with the indigenous Kenya white clover and Burchells clover, which are in their early stages, have produced no results yet except for a highly significant positive lime effect on the Kenya white, unlike liming at Kitale, which reduces its yields. On *Trifolium tembense* significant positive effects from a combination of Molybdenum, zinc and NaCl were obtained, but the omission of the salt reduced yields to the level of the controls in the absence of phosphate. These results lay the foundation for more critical long-term experiments, and they demonstrate the importance of firstly, high phosphate levels, and secondly, the interactions from certain trace elements on a soil showing no overt trace element deficiencies.

Vleis

Earlier work showed that on the type of vlei characterized by a shallow soil overlying murram, of low pH, heavy lime dressings gave good results. As liming is not justified at present, on economic grounds, a simple long-term mowing trial has been put down on vlei characterized by a dominance of *Eulalia polyneura* and *Exotheca abyssinica*. Grass analyses have shown that the uncut grasses have crude protein and fibre contents of 3-4 per cent, and 30-35 per cent respectively, and extreme poverty levels of phosphorus. By mowing, the protein contents can be increased to 6 per cent, but the herbage is still relatively unpalatable to cattle.

Effect of Legumes

Results from the use of legumes are now being obtained. The slowness of effects from Kenya white clover has already been mentioned; but with subterranean clovers sown in a pure stand and treated as a green manure crop, i.e. sown in August one year and rotavated in in June the second year, the effects have been to double the green matter yield of the following wheat crop where a vigorous clover strain was used. Grain yields are not yet available from this experiment at the time of writing. With a lucerne-cocksfoot mixture sown at various spacings, pronounced effects of lucerne on grass growth were obtained at the end of the second season, when 50 to 66 per cent increases in cocksfoot growth were obtained compared to cocksfoot sown alone. With Westerwolths-subterranean clover mixtures the gross yields of grass plus clover were 10 per cent greater from the mixture with low phosphate applications, and 20 per cent greater with medium phosphate rates, compared to grass sown alone.

Katumani Grassland Research Station

Review of Year

Pasture research work at Katumani and district increased rapidly during the year. Much time was spent on starting long-term experiments on bush control and grazing management, and the Pasture Research Officer visited various grazing

schemes to study vegetation changes. During the November rains, further ley and fodder experiments were initiated and by the end of the year a wide range of experiments was in progress. Such preliminary results as were obtained must be treated with caution, as the rainfall was much higher than average.

Rainfall	Katumani 1958	35 Years Average for Rainfall Station (Potha) in same zone 2 miles away
January	0·90	1·19
February	6·56	1·55
March	4·27	3·44
April	7·56	6·53
May	4·50	2·05
June	1·00	0·34
July	0·47	0·08
August	Nil	0·09
September ..	0·06	0·41
October	0·33	1·36
November ..	4·31	4·31
December.. ..	2·53	3·13
Total ..	32·49	24·48

Owing to the unusually high rainfall in February, there was no real dry season preceding the March-April rains.

Ley Experiments

A large number of grasses was under observation in preliminary grazing trials, including varieties of Rhodes grass, *Cenchrus, Bothriochloa insculpta, Eragrostis superba,* and Guinea grass. In general the Rhodes and Guinea grasses established easily and quickly and appeared to be more productive and palatable than *Cenchrus, Bothriochloa* and *Eragrostis superba.* These three grasses were slow to establish but *Bothriochloa* has been improving steadily, and from previous work it seems likely that the grasses which are slower to establish and less palatable are also more persistent and show less deterioration in yield. The problems involved in establishment are being studied with particular reference to the control of weeds with grasses which are slow to germinate. Seed production is being expanded so that in a few years, when the performance of different grasses is known, there will be enough seed of the best ones for fairly widespread trial in the field.

Attempts to find suitable pasture legumes have so far been disappointing. *Stylosanthes gracilis* is fairly promising but seems to be easily weakened by heavy grazing. *Clitoria ternatea* appears less promising at Katumani than at lower altitudes, and *Indigofera subulata* is reported to be slightly toxic. Until a suitable legume can be found, it is impossible to say what part legumes can play in building up fertility on red soils in the area. Lack of fertility is one of the main causes of poor crop yields on red soils, and although leys may not be much more productive than the natural grassland (at its best), any improvement in soil fertility would be of great importance.

Pot tests have revealed a slight zinc deficiency and the effect of zinc on the growth of legumes is being studied. In a fertilizer trial on Rhodes grass there was little difference in treatments at the start, but after one year of the treatments there is a visible response to nitrogen.

Fodder Experiments

Investigations on fodder production are designed to compare, firstly, annual silage crops and, secondly, perennial grasses for fodder.

Yields of silage crops grown during a season of good rain and cut in January, 1958, are given in the following table:—

Table I—Yields of Silage Crops, Tons/Acre

	Maize	Local Sorghum (Mwembe)	Perennial Kavirondo Sorghum	Bulrush Millet	Sudan Grass	L.S.D.		
						5%	1%	0·1%
Green matter	13·8	10·8	9·8	8·1	6·6	2·4	3·4	4·8
Air dry matter	2·3	2·5	2·3	1·4	1·8	0·5	0·7	1·0
Per cent air dry matter..	16·4	23·3	23·5	17·5	23·9			
Weeks, germination to cutting	11	13	13	9	11			

This experiment will be repeated over several seasons to see how the yield is affected by different amounts of rainfall.

A comparison of Napier grass varieties, Guinea grass varieties, Rhodes and Columbus grass so far suggests that Napier grass will outyield the others, although Mackinnon Road Guinea grass is yielding well.

Natural Grassland Experiments

Long-term experiments on natural grassland have been started, to study the effect of overgrazing and resting and the effect of grazing and resting treatments repeated at fixed seasons every year. The experiments have been put down on red soil at Katumani and on black soil at the Veterinary Farm, Machakos.

The effect of goats on regenerating bush is being studied at Katumani. The goats spend much more time browsing than cattle, and are able to strip the leaves off thorny bushes such as *Acacia brevispica*. The long-term effect of periodic defoliation by goats remains to be seen, but it does appear that they may be useful in areas where there is a lot of small edible bush.

The effect of burning is being studied on whistling thorn at Konza, and on dense mixed bush at Katumani, mainly to see how far repeated burns can open up areas of thick bush and reverse the tendency to become thicker, as is happening in some areas.

Visits have been made to grazing schemes in the Southern Province to study changes taking place in the vegetation under present management.

Kamasia Pasture Research Station

The Kamasia Pasture Research Station at Marigat was established in the latter part of 1956, in order to meet the need for an experimental approach to the grassland problems of the semi-arid African areas of the Rift Valley Province. The area so covered is large (including the greater part of Baringo, Elgeyo-Marakwet, Samburu and West Suk Districts) and necessitates that the work of the station be decentralized.

Although the main work of the Station is concerned with experimentation, another recognized aspect is ecological survey work which will help in the revision of the existing ecological maps of the districts the Station covers. The information gathered from these surveys, which were mainly completed last year, is invaluable as an aid to the siting of experiments, and the two aspects of the

work are therefore largely complementary. Not so directly concerned with the experimental work of the Station are the more detailed surveys of land condition and potential, which are also undertaken, but which are confined to specified areas, as requested by the Field Services. These are normally required to precede the introduction of agricultural schemes.

The problems receiving primary attention at present are:—

(*a*) The rehabilitation of habitually over-grazed areas, both by reseeding and by the introduction of remedial grazing control (including work on and within grazing schemes).

(*b*) The control of bush encroachment, with particular reference to *Tarchonanthus camphoratus* (Leleshwa) and *Acacia* spp.

Although the work of the Station is by nature decentralized, the 200-acre Chemogoch Experimental Area in South Baringo (acquired in 1957) has been developed during the year in order that certain future experiments may be brought together for their better control.

The experimental programme, meanwhile, has been increased to include eleven projects, involving fourteen individual experiments (eleven in Baringo, two in Samburu and one in West Suk), made up as follows:—

Five, three of which are now in their second year, are concerned with the technique of reseeding denuded areas. Two concern the recording of botanical changes occurring within grazing schemes, under the influence of the management imposed. Four are concerned with the control of bush, including two based on the use of bush-clearing machinery, and two, which have still to produce results, where fire is the primary agency, considering both the effect of time of burning and the interaction between fire, preliminary hand thinning and subsequent browsing by goats. Of the three experiments remaining, two are still in their early stages, one of these being concerned with the methodology of the assessment of stock-carrying capacity, whilst the other which is under the direction of the Acting Senior Entomologist investigates the effect on grassland productivity of harvester ant control: the third, the dry land nursery, allows for the assessment of the potential of selected grass material under local (Marigat) conditions.

Ecological survey work, which featured prominently last year, has been limited as a result of the expansion of the experimental programme. However, as the gathering of information for the revision of the existing district ecological maps was largely completed last year, little still remains to be done, except for the collation of the results, which pressure of other work has prevented, except for one map and accompanying notes, covering the Kerio Valley. Nevertheless, some time has been devoted to more detailed surveys of land condition and potential, and one report of this nature (for the Seya-Barsalinga area of Samburu) has been released during the year, and the preliminary groundwork for a second one has been undertaken.

Pasture Research Ranching Areas

Review of the Year

The Pasture Research Officer is still stationed on the Government Experimental Farm, Ol Joro Orok, and work in the ranching areas is conducted from this base. The preliminary work, a general survey of the ranching areas, is now complete, and a report on present management practices and condition has been written. A start has been made with experimental work on bush control. The

main lines of work have been preliminary trials with machinery and herbicides. No grazing management studies have yet been commenced. Until the final policy regarding land for experimental work is decided, little progress can be made in this direction.

A survey of the distribution of Leleshwa on the Laikipia Plateau was made during the latter part of the year. Although the species has a wide distribution in this area, there is only one major area where grazing land has been damaged. A considerable area, however, has conditions suitable for the further spread of this species.

Ranch Survey

Final visits to individual ranches were made during the earlier part of the year. Overall figures of acreages, stock and production were obtained from the Annual Agricultural Census at the East African Statistical Department.

The general degree of development, paddocking and stock-watering facilities on ranches is low, which limits improvement in management practices. The most obvious problem is that of bush invasion. A report on these findings has now been written.

Bush Control Trials

Trials with the Holt Weedbreaker, Mark IXA (Expt. 1st January, 1958)

Three preliminary trials have been started, investigating the effect of this machine on whistling thorn (*Acacia drepanolobium*). Two 20-acre plots, with large thorn trees, were treated in March, one 10-acre plot, with medium thorn trees, was treated in July, and one 5-acre plot and one 15-acre plot, with smaller thorn trees, were treated in September.

The breaker worked most satisfactorily on the medium-sized trees. Regrowth is apparent on all the treated plots, with the exception of occasional old trees which have been killed. A greater part of the regrowth is from ground level or below, with several shoots of 18 in. from each tree. There is also adventitious regrowth on the main stems, but this regrowth on the March-treated plots has now died back. Two plots, one treated in March and one treated in September, will be burned late in the dry season.

Trials with a Heavy Chain

A plot of approximately 50 acres of whistling thorn was treated with a heavy anchor chain pulled between a D.6 and a D.7 tractor in July. Several of the large trees have been killed. The majority of the trees, however, show basal and adventitious stem regrowth. The treatment effect is directly comparable to that of the Holt Weedbreaker.

The degree of control could possibly have been increased by chaining a second time in the opposite direction, but this of course would have doubled the cost.

Preliminary Herbicide Trial on Euclea Divinorum

This trial was designed to investigate the effects of 245-T and M.C.P.B. applied in different ways. 245-T was applied as a stump spray following slashing with a "Gyramor", as a foliar spray and as a basal stem spray with each plot being split for application in diesel oil and in water. The M.C.P.B. treatments were identical but the herbicide was applied as an aqueous solution only.

The herbicides were made into 1.25 per cent solutions and sufficient was sprayed on the plants to give thorough wetting. The treatments were applied in May when the plants were at a stage of growth when translocation of the herbicides could be expected.

The application of M.C.P.B. has yielded no useful results. 245-T as a foliar spray in both oil and water caused complete defoliation, die-back of the secondary branches and, on about 20 per cent of plants, complete kill of top-growth. Basal or adventitious stem regrowth is already becoming apparent on the majority of plants. The plants are, however, weakened and a second application this year will be worthwhile.

245-T sprayed on the stumps following slashing with a "Gyramor", in both oil and water has caused an apparent 50 per cent kill and weakened regrowth on the remaining plants.

245-T applied to the basal 2 ft. of the stems in an oil solution shows promise of being the most successful treatment. Many of the plants have living crowns but the bark on the basal part of the stems is dead. It it likely that the crown will die and it is to be hoped that some of the herbicide has been absorbed by the root system.

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Dougall, H. W.—

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E. D. BUMPUS,
Senior Pasture Research Officer.

ANNUAL REPORT OF THE SENIOR HORTICULTURAL OFFICER

Review of the Year

Considerable progress was made with air export trials of fresh horticultural produce. These trials are carried out by the Horticultural Co-operative Union, Kenya Canners Ltd., Hunting Clan Air Transport Ltd., the Agricultural Department and growers, working in co-operation, whilst in England at the receiving end, great help has been given by the Covent Garden wholesalers, and by the Tropical Products Institute. An efficient organization is now in existence for carrying out trials of this nature, and the horticultural industry is already beginning to reap the benefit. It is unfortunate however that after initial trials have proved that export of a particular crop is a commercial possibility, a considerable period usually elapses before regular consignments are started. This is mainly due to the very small number of horticultural producers who have a sufficiently high standard to be able to produce consignments for export. Another reason is the need to zone the production of some crops within a reasonable distance of Nairobi Airport, both for economical transport, and to ensure that the product arrives there in the freshest possible condition.

There has always been a small trade to the Persian Gulf, mostly as deck cargo on small vessels. The availability of some ships with refrigerated storage is now bringing about an increase in this trade. As all produce now has to be inspected before export, it will be possible to enforce higher standards of grading and packing. This is essential if the trade is to be developed.

Prices for horticultural produce on the local market have dropped during the year, and are now at a more realistic level. Generally, high quality produce still sells for a reasonable price, but that of a very low standard is more or less unsaleable. It can be expected that the less efficient and less favourably situated growers will tend to drop out of production.

Investigations were started into the possibility of developing an export industry for citrus juice. There appears to be a market in the United Kingdom for a considerable quantity of lemon juice, and a smaller quantity of lime juice. Although the biggest demand is for orange juice, the market is far more competitive, and it would not be advisable for us to enter it. Investigations are continuing, and it is expected that a decision will be made during 1959 on whether the proposed industry is likely to be an economic proposition.

The Kenya Citrus Growers Association are finding a considerable demand for their fruit and new acreage is being planted. A serious problem in East Nyanza is poor colour in oranges; investigations are being made to combat this.

Trial exports of avocados to Aden realized good prices, but insufficient fruit of the quality required were available to maintain supplies. The Fuerte avocado, which is giving very high yields at our Jacaranda sub-station, is the variety required for export, and a small commercial acreage in this area might well be planted. Further investigations are to be made into the possibility of establishing an oil industry with avocados.

Trial exports of litchi to London have been very successful, but production is practically non-existent. This trade cannot be developed unless new acreage is planted. Fruit is also required for the local market. Trees are being imported to provide a source of material for propagation.

The plum market was depressed this season due to a glut of fruit. The crop from Fort Hall was much heavier than before, and being of fair quality sold for a reasonable price.

Exports of Malindi mangoes continued successfully, but owing to lack of packing and grading facilities, they continue to be on much too small a scale. Difficulty is being experienced at the coast in raising mango seedlings owing to die back of the seedlings. The cause is being investigated.

In 1958, 13,886 tons of pineapples were processed by the canners in Kenya, and in July the increased competition on the world markets from other canned pineapple producer countries led to a drop in the price paid to the grower. To meet this trend, which is likely to continue, every effort must be made to reduce the cost of production and to improve the quality of fruit.

Export trials of strawberries to the London market in the Christmas period were successful. The early consignments fetched low prices but these improved to Sh. 12 per lb. Much of the fruit was produced too far up-country, and it would be more satisfactory if production were zoned in the Limuru-Uplands-Bamboo Forest area. There is now a considerable acreage established with imported plants of Cambridge Early Pine and Favourite which is likely to come into production during the first half of 1959. The price on the local market is therefore likely to fall, and increased effort will be necessary to find additional markets.

Export trials with Cape gooseberries from Molo were extremely successful, the fruit selling for as much as 25 cents each in Covent Garden. This can only be a small trade, but nevertheless should be followed up. Trials will be continued next season.

Tomatoes grown for canning in the Trans Nzoia, Nakuru, and Naivasha districts gave reasonable yields, and this is partly due to greater experience of the crop on the part of both growers and canners. The drop in maize prices has also encouraged production. Good yields were also obtained at the Mwea Irrigation Scheme, but at Perkerra the crop grown by tenant farmers failed, and owing to the difficulties of production in this area, tomatoes are to be abandoned.

Record of Investigations

Tree Crops

Apples

After 12 years' work on apples at Molo it must be definitely admitted that the yield of fruit is very low, as is indicated in Table I below which shows the mean annual yield of four varieties.

Variety	Rootstock	Date Planted	Mean Annual Yield of 4 Trees in lb.								Average Yield
			1951	1952	1953	1954	1955	1956	1957	1958	
Sharps Early ..	Crab	1947		—	8	9	3	37	27	43	21
Abundance ..	Crab	1946	2	6	13	14	51	45	45	49	29
Ballarat ..	Cape Seedling	1947	—	—	—	7	2	25	22	26	16
Kings of Tomkins County	Crab	1946	¼	3	10	7	7	22	98	45	24

Nevertheless, in Kenya where apples fetch a high price, it would appear that they are still an economic crop. The cost of maintaining the orchard during the early unproductive period can be met by interplanting with pyrethrum. Close planting of the apple trees at 20 ft. x 10 ft. gives 217 trees per acre, and assuming that the average annual yield is only 20 lbs. of saleable fruit, the return per acre at 75 cents per lb. would be Sh. 3,255.

The main problem in deciduous fruit production in Kenya is lack of sufficient winter chilling. This results in poor growth and a poor set of fruit, whilst shortage of leaves on the trees during the cropping period causes physiological cracking and other disorders of the fruit. Although the altitude of the Molo Station is 8,200 ft., apple trees grown there receive less effective winter chilling than in several other districts. This is due to the comparatively high number of hours of sunlight during the period from June to August.

It has been observed that in Limuru and on the Kinangop apples give better results than at Molo, because these districts receive considerably less sun during this period of the year. In planning future commercial plantings of apples in Kenya, therefore, the climatic factor must be regarded as of the first importance, the ideal being an area which receives low mean temperatures and a minimum of direct sunlight during the period June-August, and reasonably high mean temperatures for adequate ripening of the fruit, from November to April.[1][2]

Plums

The trial to establish the optimum time for spraying plums to break dormancy, first carried out in 1957, was repeated, but owing to unsatisfactory weather conditions no definite result was obtained. [1][2]

Peaches

Trials in top working with a new variety, old trees of varieties which have proved unsatisfactory at Molo, have been successful. The old branch system is cut back to a height of about 3 ft. Sucker growths which arise from the stumps are budded with the new variety when they are about $\frac{3}{8}$ in. in thickness. At Molo scions of the variety "Ventura" top worked in this way have borne a heavy crop 18 months after budding.[1][2]

Citrus

Preliminary investigations were started on the proposed export industry for lemon and lime juice. Samples of lemons from several varieties grown at Jacaranda, Perkerra, Matuga, Kitale and Londiani, were collected and samples of juice prepared at the Scott Agricultural Laboratories. These were distributed to members of the trade in the United Kingdom, through the Tropical Products Institute. An interim report on the samples indicates that the juice from the varieties Eureka, Villa Franca, and Lisbon, might be acceptable for export, but as Eureka is a somewhat low yielder, it has been decided to concentrate future work on Villa Franca and Lisbon. Samples of Meyer and Rough Lemon were unsuitable for the trade, whilst all samples from Kitale and Londiani were reported to be too weak in flavour. Only one sample of lime juice was sent; this was condemned by the trade on the grounds of wrong preparation. Investigations are continuing.[1]

A comparison of fruit from trees on Rough Lemon and Sweet Orange rootstocks at Matuga, shows that fruit from trees on Sweet Orange is superior in all respects. It is unfortunate that Sweet Orange rootstock is considerably more difficult to raise and to bud than Rough Lemon; it is therefore unpopular with nurserymen.[5]

Avocados

The returns from trial consignments exported to the United Kingdom by air show that we cannot compete with fruit coming in by sea from other countries. A reasonable return has however been obtained from trial consignments to Aden, and this trade is likely to develop.[2]

Trees at Jacaranda are now giving satisfactory yields, as can be seen in the cropping figures for 1958 of three varieties, Table 2 below.

TABLE 2—MEAN YIELD OF 3 TREES

VARIETY	Irrigated Yield in lb.	Unirrigated Yield in lb.
Fuerte	395	144
Puebla	179	129
Mayapan	621	241

In 1950 the possibility of producing avocado oil for the cosmetics industry was raised, but reports indicated that the market was too small and uncertain. Since that time we have received enquiries for avocado oil for soap manufacture. Avocado oil is also a high quality edible oil. In view of the yields now being obtained, it would seem worthwhile to re-examine the possibilities of an oil industry.

Pineapples

PLANT MATERIAL TRIAL, RUIRU

A trial with four replications was designed to compare the effect of different types of plant material on yield, harvest period and length of cycle. Plantings were made on 9th May, 1955, on bench terraces of Kikuyu red loam which had never previously been planted to pineapples using the two-row bed system of 1 ft. between plants, 2 ft. between rows, and 3 ft. between the beds. The soil fertility was considered to be low and sulphate of ammonia at 1,000 lb./acre was applied.

Following severe iron deficiency symptoms, ferrous sulphate at 2 per cent concentration was applied to the foliage on five occasions before fruiting commenced. The results of the plant crops are shown in Table 3.

TABLE 3—MEAN RESULTS

TREATMENTS	Weight of Planting Material	Yield per acre/tons	Mean wt. fruit lb.	No. fruits per acre
(1) Mixed Crowns	2 oz. to 4 oz.	24·45	3·30	16,575
Uniform Crowns	4 oz.	25·56	3·41	15,575
Small Slips	1½ oz.	19·85	2·97	14,875
Medium Slips	2½ oz.	23·24	3·20	16,150
Large Slips	6 oz.	22·62	3·20	15,725
Mixed Slips	1¼ oz. to 6 oz.	20·47	3·28	14,025
Small Suckers	4¾ oz.	23·70	3·13	16,575
Medium Suckers	10 oz.	27·02	3·62	16,575
Large Suckers	19 oz.	30·29*	4·01*	16,575
Mixed Suckers	4¾ oz. to 19 oz.	30·42*	4·01*	17,000
L.S.D.'s		5·22* 7·04**	0·66*	

The low mean weight of fruits from the crowns, slips and small and medium suckers is a reflection of the low fertility factor. Although the number of fruits per acre have not been statistically analysed, there is no indication that any increase in fruit production would have significantly increased the lower yields of the small and mixed slips.

By far the best results were obtained with the large and mixed sucker material. This however must not be considered conclusive until the yields from the ratoon crops are available.

The harvesting pattern of the three main types of planting material is shown in Table 4.

TABLE 4—HARVESTING PATTERN

Percentage harvested on a month to month basis (Cumulative)

Planting Material	1956									1957										
	A.	M.	J.	J.	A.	S.	O.	N.	D.	J.	F.	M.	A.	M.	J.	J.	A.	S.	O.	N.	D.
Uniform Crowns	—	—	—	—	—	—	—	—	—	—	20	73	78	86	86	90	92	93	95	96	97
Medium Slips	—	—	—	—	—	—	—	—	—	—	5	37	39	46	46	50	68	83	88	91	95
Large Suckers	2	Nil	3	25	41	43	65	71	78	90	95	97	—	—	—	—	—	—	—	—	—

Harvesting from the sucker material started earlier than from both the crowns and slips, and the time taken by the sucker material to complete the plant crop phase was only 23 months compared to the 32 months required by the crowns and slips.

The bulk of the harvest from the crowns was made in the first four months of fruiting, but with the slips harvesting was very slow and uneven. In four months, 86 per cent of the crown fruits were harvested while it took eight months to harvest 83 per cent from the slips. With the suckers harvesting was also on the slow side, taking nine months to harvest 73 per cent of the crop. However, the overall time taken to harvest the plant crop was about 11 months from each type of material.

Growers are advised not to plant large suckers until the final results of this trial are to hand.[3]

PLANT MATERIAL TRIAL, FRUIT STATION, RUIRU

The object of this trial was to compare the influence of preplanting treatments of the planting material on establishment and yields. This trial was planted in May, 1955, under identical conditions to the previous trial. The results of the plant crop are given in Table 5.

TABLE 5

TREATMENTS	Yield Acre/ Tons	Mean wt. fruit lb.	No. fruits per acre
Fresh Crowns. *a*	23·63	3·38	15,300
Fresh Crowns. *b* (1)	24·72	3·53	15,300
Fresh Slips. *a*	20·47	3·09	14,875
Fresh Slips. *b*	20·51	3·13	14,025
Crowns dried out for 1 month	24·01	3·24	16,575
Crowns dried out for 2 months	22·58	3·08	16,575
Slips dried out for 1 month	21·98	2·99	16,150
Slips dried out for 2 months	21·09	2·85	16,575
	No significant differences		

a.—Dipped in Abavit Fungicide. *b.*—Untreated. (1).—Control.

The analysis of the yield results shows that there has been no significant differences between the treatments. The numbers of fruits per acre have not been analysed but their influence is unlikely to have had any significant effect on the yields.

The trial has shown that drying out of the planting material for periods up to two months had no significant influence on yields and therefore the material may either be planted fresh or be dried out for up to two months if this is desirable. The fungicide treatment of the fresh material had no influence on yields. None of the treatments appeared to have any marked influence on establishment following planting. Drying out of the planting material might however be beneficial before planting on heavy soil or cambered beds.[3][7].

Nutrition Trial, Horticultural Sub-station, Ruiri

This trial was instituted by Mr. J. B. D. Robinson, Agricultural Chemist (Coffee), to compare the influence of fritted trace elements (F.T.E.) and chelated fertilizers as an addition to sulphate of ammonia.

The trial was started in November, 1955, and was concluded in June, 1958, or 31 months after planting. Planting was on bench terraces of very low fertility Kikuyu red loam. Spacing was at 1 ft. × 2 ft. × 3 ft. or 17,000 plants per acre. The planting material was fruit crowns. Harvesting started 22 months after planting and continued for nine months. The treatments and yield results of the plant crop are given in Table 6.

Table 6

Treatments	Yield acre/ Tons	Mean Fruit wt./lb.	No. Fruits per acre
A. Control	2·80	1·48	3,400
B. Sulphate of ammonia at 2,500 lb. per acre ..	13·36	2·54	11,305
C. B + Fe complex (lignin sulphonate) 2 mls/ plant	16·65	2·96	12,155
D. B + F.T.E. 1 grm/plant	12·47	2·49	11,050
E. B + Mn. chelate 0·5 grm/plant	15·20	2·60	12,495
F. B + Fe. chelate 0·5 grm/plant	17·54	2·97	13,005
G. B + Mg. chelate 1·0 grm/plant	15·08	2·62	12,750
H. B + Mn + Fe chelate 0·5 + 0·5 grm/plant	14·72	2·65	12,155
I. B + Mn + Fe + Mg Chelate 0·5 + 0·5 + 1·0 grm/plant	14·54	2·63	12,155
L.S.D.'s 5·0%	4·02	0·51	3,153
1·0%	5·54	0·71	4,344
0·1%	7·62	—	5,976

The largest single factor effect on yields has been the sulphate of ammonia. The addition of iron above, both as the lignin sulphonate and the chelate, has increased the yield over that obtained with sulphate of ammonia, and at the same time increased the mean weight per fruit and the number of fruits produced.[3][7]

Herbicide Trial

Apart from the control of couch by Dowpon, little of practical value has been derived from the use of other chemicals to control couch or broad-leaved weeds in pineapples. Though there has been no evidence from any of the Dowpon trials to indicate that couch grass can be eliminated, the measure of control is

such that couch can be suppressed sufficiently to prevent competition with pine-apples. The chemical can cause yellowing of foliage and slight suppression of growth when used on plants up to one year old. On older plants and ratoons in fruit, no damage has been observed. Following the initial treatment, retreatment is necessary as regrowth occurs. One of the oldest trials has required treatment on five occasions in 24 months. The initial treatment was at 10 lbs. per acre followed by four retreatments at 5 lbs. per acre.[3]

Observational Trial at Mwea/Tebere

The object of the trial was to find whether fruit of a suitable quality for canning could be grown under the rather high temperature conditions at Mwea/Tebere. The trial was planted on red soil in the short rains 1956, and produced a plant crop at the rate of 17 tons per acre, between February and December, 1958. The fruits proved to be much too large for canning, and their sugar/acid ratio was far too high, being 38.5:1, whereas a ratio of 16-20:1 is required by the canneries.

Fruit of this quality might be very suitable for export as fresh fruit. A large fruit is required for this trade, and many people consider that fruit of canning quality is too acid for fresh consumpton. A further trial is to be laid down to test the fruit for export.[6]

Berry and Other Fruits

Strawberries

Trial export consignments to Covent Garden were started in October. Early consignments fetched only Sh. 6 per lb., but as more experience was gained in handling the crop, the fruit arrived at its destination in better condition, and the price rose to Sh. 12 per lb. At the latter price, the net return to the grower in Kenya is Sh. 3/50 per lb., which is considered satisfactory. Pre-cooling the fruit before air shipment has proved important.[2]

Strawberry Breeding

Work on mass selection of seedlings, as reported in the Annual Report for 1957, is continuing at Molo. Five selections have been made from the first large batch of seedlings. These have now been multiplied vegetatively from single plants, and the five lines are under trial at Molo and Thika.[1][3]

Passion Fruit

Trial consignments of fresh passion fruit (*P. edulis*), were successful exported by air to Covent Garden. The first consignment packed in rather large cardboard cartons did not arrive in good condition owing to insufficient ventilation. Later consignments packed in ventilated cartons, each holding 130-140 fruits were well received. Fruit was graded into three sizes which sold for 4d large, 3d medium, and 2d. to 3d. small. After deduction of all expenses, the fruit made just over Sh. 1/70 per lb. Production near Nairobi is required in order to develop this trade. Trials will be continued in 1959 with fruit from the Thika station[2].

Cape Gooseberries

Experimental consignments of Cape gooseberries sent to Covent Garden by air were extremely successful. Only large fruit is required, and the minimum size sent weighed 5 gms. So far, it has been possible to produce such large fruit, only at Molo and similar altitudes. Fruit must be sent in the husk, and the husk must be thoroughly dry before packing. Packing is 50 fruits in a 1 lb. size

punnet, and 12 punnets to a carton. The fruit sold for Sh. 15 per punnet, giving a net return in Kenya of Sh. 9 per punnet. Trials are to be continued this season with larger quantities of fruit from Molo, and an attempt will be made to keep up a regular supply. The market, at this price, is of course limited.[1][2]

Melons and Cucumbers

During the year three observational trials on the red soil at Mwea/Tebere have been done on Cantaloupe melons and two on cucumbers, both of which show considerable promise, but it is clear that success with melons depends very largely on correct choice of planting season. The fruiting period must be in dry, cloudless weather otherwise it is wiped out by leaf mildew. The table below shows the sowing and harvesting dates and yields of each trial in lb. of marketable fruit per acre.

	Melons	Cucumbers
Sowing date	9th January	—
Harvest dates	April	—
Yield	3,200 (approx.)	—
Sowing date	17th May	17th May
Harvest dates	—	11th July—9th Aug.
Yield	Nil (due to mildew)	5,838 lb.
Sowing date	26th July	26th July
Harvest dates	15th Oct.—10th Nov.	22nd Sept.—3rd Nov.
Yield	3,516 lb.	3,920 lb.

Spacing used in the two later trials was 6 ft. x 4 ft. with two rows on a 12 ft. ridge and this appears to be optimum and allows economy of watering. Baiting with malathion/molasses was done against "fly" in the two later trials by flicking the mixture onto the plants in large drops with a paint brush at weekly or fortnightly intervals after fruit setting had started. This treatment seems fairly effective although appreciable fly damage still occurred and with cucumbers fruit distortion resulted in much loss of saleable crop in the later pickings of both trials. A further trial of both crops was planted on 6th November. It is thought that this may be the best planting time of all because there should be a very long dry season for picking.

On the black soil $\frac{1}{8}$-acre observation plots of melons and cucumbers were planted on 24th July. The cucumber yielded only 2,244 lb. of saleable fruit per acre compared with 3,920 lb. from the red soil trial planted at the same time. The melons yielded practically nothing due to heavy mildew attack.[6]

Tomatoes

Variety Trial, Thika

Fourteen varieties of tomatoes were tested for the fresh market. A Randomized block design with three replicates, each consisting of 20 plants, was employed. On 24th April, 1958, the tomatoes were planted on newly-broken deep red Kikuyu loam at a spacing of 3 ft. by 2 ft.

The soil was dressed with F.Y.M. at 10 tons per acre before planting in 3 ft.-wide strips and the plant rows laid out on these strips. Double superphosphate at 100 lb. per acre was applied on planting, and sulphate of ammonia at 100 lb. per acre on establishment. On completion of the rains overhead irrigation was applied at approximately one inch per week. In total the plants received 38.01 in. i.e. rainfall 32.91 in., irrigation 5.1 in.

The plants were sprayed weekly against "Blight" (*P. Infestans*) with Blitox, to which 50 per cent wettable D.D.T. was added when the fruit had set, as a control for Tomato Worm (*Heliothis*).

Due to the unevenness of the "Blight" attack it was not possible to analyse the trial statistically. The results are given in Table 7.

TABLE 7

VARIETIES	Yield Tons Acre	Description	No. of Fruits per lb.	Diameter	Height
German Strain No. 9	10·4	Fruit green inside, too small to be of use	34	1·3″	1″
Hundredfold ..	12·7	Well shaped fruit, flesh red	6	2″ +	1·3″ +
German Strain No. 8	10·1	Well shaped fruit, although grooved, flesh good.	5	2·5″	2″
Master Marglobe ..	7·7	Fleshy, well shaped fruit, though the calyx and occasional cracks tend to spoil appearance	5	2·5″	2·3″
Tatinter	11·6	"Cat faced" fleshy, too distorted for fresh market	4	3·4″	1·5″
K.Y.I.	9·4	Round fleshy, ridges around calyx spoils appearance	3	2·5″	2·3″
Pearson	11·8	Very fleshy, slight "Cat face" spoils appearance, calyx very deep ..	3	3″ +	2·5″ +
Amateur	13·0	Good shape, good colour, good fresh market fruit	6	2·3″	2·3″
Rutgers	11·5	Round, fleshy, good colour, rather large calyx	7	2·2″	2·2″
German Strain No. 10	13·1	Fruit shape good, but hollow inside ..	7	2·2″	2″
Bawley Selection ..	8·6	Rather flat, slight "Cat face", very fleshy	4	3″	2″
Homestead	8·7	Good shape, seeds green, large calyx may spoil appearance	4	2·6″	1·5″
German Strain No. 7	10·6	Good shape and colour, seeds green, good for fresh market	6	2″	1·5″
T X 28 A (9:1:3) ..	6·2	Fleshy, deep calyx, prounonced "Cat face"	4	3·5″	2″

Of the above varieties the following were most in demand for sale on the fresh market, Hundredfold, Amateur, German Strain No. 7, German Strain No. 8 and Homestead. [4]

BLIGHT CONTROL

Four proprietary fungicides were tested for their efficiency against tomato blight (*P. Infestans*). Tomatoes, variety Hundredfold, were planted at a spacing 6 ft. by 3 ft. by 2 ft. on 25th April, 1958. The design was randomized block with four replicates; each replicate consisting of 40 plants. Due to a delay in receiving Kaptan the whole trial was sprayed with Blitox until 3rd June, 1958. Seventeen applications were made at weekly intervals using the recommended concentration of each material. The treatments were applied with a stirrup pump and handlance at the rate of 400 gallons of wash per acre. The results are given in Table 8.

TABLE 8

MATERIAL	% Concentration	Total Yield Tons/Acre	% Diseased Fruit
Dufox	0·3	15·0	0·20
Kaptan	0·2	13·7	0·32
Blitox	0·3	10·1	0·87
Zineb	0·3	16·0	0·17
Control	—	4·6	35·30

All materials gave a significant increase in yield over the control. Dufox and Zineb gave a significant increase (P=.05) over Blitox, but Dufox could not be recommended for commercial use on tomatoes owing to its mercury content.

VARIETY TRIAL, MWEA-TEBERE

The trial was designed to compare the yield and canning quality of 14 tomato varieties. The design was three randomized blocks of 14 plots each. The plot size was 1/121 acre, and the plant spacing was 10 ft. x 1 ft. The trial was planted on red soil at the Irrigation Research Station; no manure or fertilizer was applied.

Seedlings were transplanted from seedbeds on 30th April, but heavy rain necessitated almost complete replanting on 6th May; further gapping up was done later. Spraying with Burgundy mixture against blight (*P. Infestans*) began on 22nd May and continued fortnightly. D.D.T. being added from 3rd July onwards to control *Heliothis*. Irrigation was carried out three times.

TABLE 9

VARIETY	Saleable Fruit Tons/Acre	Unsaleable Fruit Tons/Acre	% of Saleable Free of Internal Blossom End Rot
Ariana 3 Ex S. Africa	14·84	2·24	77·78
Arian 3	12·63	1·21	82·47
Stonors Supreme	11·64	1·55	81·87
Stonors Exhibition	11·44	1·33	63·88
Stonors Choice	All Plants Died Out		
Ariana 8 Ex S. Africa	10·87	1·75	72·93
Stonors Moneymaker	10·73	0·98	77·58
Stokecross 1	10·55	1·99	70·24
Roma W. R.	10·42	1·20	74·53
Stokecross 6	9·52	1·85	62·73
Pearson	9·45	2·05	79·09
Stokesdale	9·07	1·26	88·12
Ariana 8	7·98	0·90	77·82
Lampadina	7·89	0·89	58·25
Mean	10·54	1·40	74·41
Least sig. difference @ 5%	8·25		

No varietal yield difference are significant. The highest yielders were the Ariana varieties with the exception of Ariana 8; and the Stonors varieties with the excepton of Stonors Choice which failed to establish. Of these, Ariana 3 and Stonors Supreme were also notable for their relative freedom from internal blossom end rot, but this was based on only a single examination.

On canning quality the report of Kenya Canners Ltd., Thika suggests that the four Ariana varieties, the two Stokecross varieties, Pearson, Lampadina, and Roma W.R. are received with the most favour. Lampadina however was the lowest yielder and seemed most susceptible to internal blossom end rot.

For the fresh market the Stonors varieties which are all small, round plum-like fruits were fairly acceptable in Nairobi, as was Pearson, a rather larger, rounded fruit. The pure canning varieties—Ariana, Roma and Lampadina were only saleable during periods of severe shortage in Nairobi.

The general level of yield was well above that of previous trials and this is probably mainly due to transplanting in the long rains and having a long almost rainless picking season of three months before the onset of the short rains. The proportion of unsaleable fruit was reduced to a low level because of the relative low incidence of blight and *Heliothis*. The fortnightly spraying with Burgundy mixture, and the addition of D.D.T. as soon as the first fruits formed, seems to have been satisfactory.[6].

Spraying and Spacing Trial, Mwea-Tebere

The trial was laid down in the short rains, to compare three different frequencies of spraying with Burgundy mixture against blight (*P. Infestans*), and of D.D.T. against *Heliothis*, on the yield of Lampadina tomatoes for canning, and to compare three different plant spacings.

Treatments were as follows:—

Spraying with Burgundy mixture: nil, fortnightly, and after rain only. The first spray was applied soon after the plants were established. Spraying with D.D.T.: the D.D.T. was mixed with the Burgundy mixture and applied at the same intervals, but the first application was made when the first fruit trusses were forming. Spacing: Inter-row spacing was 6 ft. throughout; spacing in the row was at 12 in., 18 in. and 24 in.

The design was 3^3 factorial with single replicate of 27 plots and second order interaction confounded. Plot size was 1/51.6.

Farmyard manure was applied at the rate of 10 tons per acre before planting, and the trial was planted on red soil with seedlings on 26th November. Picking started on 14th February and continued until 28th April, when the long rains brought the crop to an end.

The results show that in this particular season *Heliothis* was a limiting factor for tomato yields, and spraying with D.D.T. either fortnightly or after rain gave a significant yield increase of over two tons per acre. No appreciable outbreak of blight occurred during this season, spraying with Burgundy therefore had no effect on yield. As D.D.T. has to be applied anyway, it is probably worthwhile to mix Burgundy with it, as an insurance against blight. There was no yield difference between the different plant spacings.[6]

Fertilizer Trials, Mwea-Tebere

Two trials were carried out with the canning variety Lampadina, the first in the short rains 1957-58, and the second in the long rains 1958. A statistical design was used in each case.

In the first trial, which was planted on red soil on 26th November, 1957, with seedlings, the treatments were, sulphate of ammonia at 1 and 2 cwts. per acre, applied about two months after planting; double superphosphates at 1 and 2 cwts. per acre, applied in the planting holes; farmyard manure at 10 and 20 tons per acre, dug in before planting.

The trial was sprayed fortnightly with Burgundy mixture against blight, and after fruiting began, D.D.T. was added to control *Heliothis*. Picking started on 24th February, 1958, and continued to 24th April, when it was brought to an end about a month before the crop would normally have ended, by the start of the long rains. There was no response to sulphate of ammonia, due it is thought, to the application having been made two months after transplanting, instead of at the time of transplanting. No response also was obtained with superphosphate, but this is in line with results with other crops on this soil. Farmyard manure

at 10 tons per acre gave a significant increase in yield of about 1½ tons saleable fruit per acre. Only a very small non-significant increase in yield resulted from F.Y.M. at 20 tons, as opposed to 10 tons. The higher rate of application is in any case unrealistic for farmers in the area.

In the second trial which was planted on red soil on 30th April with seedlings, the treatments were, sulphate of ammonia, double superphosphate, and gypsum, all at 2 cwt. per acre and a trace element mixture at 75 lb. per acre. The mixture contained copper, zinc, molybdenum, manganese, and borax.

All treatments were applied in a ring round each plant and lightly covered with soil on 22nd May. Routine spraying was carried out as for the first trial. The experiment grew very well, probably largely due to being planted in a rainy season. There was very little blight damage and less *Heliothis* than in previous seasons.

The results show that sulphate of ammonia at 2 cwt./acre raised the yield from 16.60 tons to 19.28 tons saleable fruit per acre, a very significant increase. There was no effect on yield from phosphate, gypsum, or the trace element mixture. None of the treatments caused any reduction in the amount of unsaleable fruit. Sulphate of ammonia possibly caused a slight increase, but this is not regarded as of practical importance. No treatment had any beneficial effect on the incidence of internal blossom end rot, with the possible exception of gypsum. This effect was based on only a single count of affected fruit, and is therefore not very reliable.

The very satisfactory general level of yield and the very low proportion of unsaleable fruit (3-4 per cent) is noteworthy. This is attributed partly to good establishment and growth obtained by planting in the long rains, and partly to a very long, dry picking season, and finally to effective control of *Heliothis* by spraying with D.D.T.[6]

Other Vegetables

Asparagus, Period of Cutting Trial

The second season's results from this trial at Molo, indicate that there is a correlation between high soil temperatures and high yields. As the results are for two seasons only and they have not yet been statistically analysed, only a tentative conclusion can be drawn at present, but it does appear that it would be safer to base recommendations on the best time to cut asparagus in Molo and similar climates, on the soil temperature during that particular season than on a calendar date. Table 9 shows results for two seasons during the period September-May.

Table 9

Year	Cutting Period	Yield per acre lb.	Rainfall Inches	Soil Temp. °F.
1957	Sept.—Oct.	1,330	2·31	66
1958	,,	900	9·23	64
1957	Dec.—Jan.	1,470	4·82	65
1958	,,	1,269	7·17	64
1957	Feb.—Mar.	2,730	5·78	67
1958	,,	1,227	7·89	66
1957	Apr.—May	1,260	6·01	65
1958	,,	2,859	8·71	67

[1], [2]

Canning Tests with Asparagus

The results of tests carried out by Kenya Canners on samples of asparagus grown at Thika, Mwea, Kiambu, and Nyeri were considered to be sufficiently promising to justify a recommendation to plant the crop for canning in areas within a reasonable distance of the cannery.

Onion Seed Production

In order to investigate the possibilities of onion seed production, an observational trial was laid down at Thika to compare two water regimes and two planting distances. Over-sized bulbs var. Bombay Red which had been harvested on 22nd April, 1958, and ripened for one month were planted on 27th-30th May, 1958, on bench terraces of red Kikuyu loam. No manure was applied before planting since the land had received heavy applications for previous crops. Triple superphosphate at 100 lb. per acre was worked into the soil at planting time. 50 per cent wettable D.D.T. at 2 lb. per acre was applied at weekly intervals to control thrips.

The treatments were as follows:—

Block I—Minimum of 1 in. water per week—

A. 9 in. x 6 in. spacing (385 bulbs per plot)

B. 18 in. x 6 in. spacing (210 bulbs per plot)

Block II—Minimum of 1 in. water two weeks—

C. 9 in. x 6 in. spacing

D. 18 in. x 6 in. spacing

One month before harvesting the seed heads were attacked by Mildew *Perenospora destructor* which was most severe in the closer spaced 9 in. x 6 in. bulbs. The seed was harvested on 27th October, 1958, a sample tested for germination gave 76 per cent.

The yield from the lower watering regime (15.33 in.) was negligible, but that from the higher regime (25.10 in.) although low was sufficiently encouraging to justify further investigation. The wider spacing gave the best yield.[4]

Bombay Red Onions at Mwea-Tebere

A half-acre observation plot was grown on the red soil and quarter-acre on the black soil. Neither plot was manured or fertilized. Spacing was 6 in. x 6 in. on broad 8 ft. ridges separated by irrigation furrows. A fairly complete stand was achieved by transplanting from seedbeds in the long rains in late April. Harvesting was from late August to early September. Yields were low: $1\frac{1}{2}$ tons per acre of dry bulbs on the red soil and $\frac{3}{4}$ ton per acre on the black. Low fertility was probably the main cause in both cases, plus an attack of onion thrips on the black soil trial. Heavy manuring should be done for onions here in future, probably including sulphate of ammonia at transplanting to give the crop a good start.[6]

Garlic

A half-acre observation plot was planted on the red soil in January in dry weather so that establishment had to be by irrigation. No manuring was done. Establishment was very patchy giving a low population, growth generally was poor and final yield of dry "bulbs" at 360 lbs. per acre must be a "record low". This again like onions is clearly a crop requiring heavy manuring on this soil and is best planted in a rainy season to ensure a full stand. [6]

Indian Vegetables

Observational trials were carried out at Thika on a number of Indian vegetables. Of these Radish var. Long White, Polak (Spinach), and Turia were the most promising.[4]

Miscellaneous Crops

Hops

Previous work at Molo has established that cultivated varieties of hop will not make normal growth unless the day length is extended to 15 hours. However the value of hop imports makes it desirable that hops be produced locally, and further work on hops has therefore been started at Molo. It is hoped that by importing hop seed from many parts of the world, and mass selecting the resultant seedlings, we shall be successful in selecting seedlings which will grow normally in a 12-hour day length.

Seed of five varieties was received from Wye College, and many seedlings raised at Molo. Nearly all seedlings died after they had made a few inches of growth. Growth elongation was obtained by treatment of some seedlings with Giberellic acid, but the growth produced in this way was so etiolated that the plants afterwards withered and died. A second batch of seedlings produced from American seed was largely destroyed by hail. Investigations are being continued.

Publications

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References

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Senior Horticultural Officer.

ANNUAL REPORT OF THE SENIOR PYRETHRUM OFFICER, 1958

Meteorological

A comprehensive and more detailed report will be published by the Pyrethrum Board of Kenya. This will also contain meteorological records for the various stations.

Unseasonal rains from November, 1957 to March, 1958 resulted in heavy flushes during February and March. Then after cutting back the pyrethrum was very slow and produced but poorly. This, most likely, can be attributed to the lack of a dry season and poor nitrification (J. Glover and H. C. Birch, East African Agricultural and Forestry Research Organization, verbally). The position was aggravated through severe thrips attacks which prevailed during a large portion of the season and comparative shortage of rain, at least in the western regions, from July to December. The total flower production in Kenya was 8,565,287 lb., an increase over the same period in 1957 by 1,022,265 lb. which was due mainly to an enlarged acreage, but it can also be stated that the general standard of cultivation has improved. The average pyrethrins content of 1.35 per cent was 0.11 per cent lower than in the preceding year; this can most probably be attributed to a general rise in mean temperatures, although other factors may be responsible as well. The incidence of *Ramularia* bud disease was low but physiological bud rot was quite common at times. This trouble is now being studied by the Plant Pathologists of the Coffee Berry Disease Team.

Experimental Work

Fertilizer Trials

Nineteen trials of different design and purpose were kept up during the year.

On reddish, rather poor and fairly acid soils of the higher altitudes the following results were recorded:—

Table I

Yields in lb./acre of dry flowers

Treatment	Roller, Upper Gilgil	James, Mau Summit
Control (no fertilizer)	49	676
200 lb./acre Triple Supers	190	928
100 lb./acre Muriate Potash	34	622
3 tons/acre Lime	76	689
Supers + Lime	167	986
Potash + Lime	73	583
Supers + Potash	183	1,005
Supers + Potash + Lime	233	903

Both trials were planted in 1958.

TABLE II

Yields in lb./acre of dry flowers

TREATMENT	Schalch, T'Falls	South Kinangop
Control (no fertilizer)	162	290
150 lb./acre Triple Supers	310	340
300 lb./acre Triple Supers	321	376
450 lb./acre Triple Supers	—	418
Planted on level	258	—
Planted on ridge	271	—

The trial at Thomson's Falls was planted in 1956 and the trial on the South Kinangop in 1957.

In none of the trials comparing the action of superphosphate with that of basic slag has either of the two fertilizers proved superior.

The Mulch Trial at Subukia has given the following results over three seasons:—

TABLE III

Yields in lb./acre of dry flowers.

Control (No mulch)	1,543
Half mulch	1,936
Full mulch	1,814

The Variety/Phosphate Trial on the Grassland Station, Marindas, has shown a marked effect of superphosphate on all varieties during the second season, the average yield increase being 200 lb./acre dry flowers.

ROTATION TRIAL

This experiment at Ol Joro Orok is now in its 12th season. The analyses of soil samples have shewn no serious deterioration of the soil structure under permanent pyrethrum as compared with a pyrethrum/grass rotation.

STRIPPING TRIAL

This trial at Ol Joro Orok has indicated that stripping down to and including buds would normally result in a produce with a lower pyrethrins content and diminished yields so confirming earlier findings at Molo.

Plant Breeding

Five hundred and eighty-six new single plant selections were made and 19 new hybrids (crosses) produced on the various stations. 20 yield trials in different parts of the Highlands were maintained or planted to test the behaviour of new varieties under varying conditions. New seed production fields were established for C. 35, C. 92, M. 9, M. 21, O.4 and the two sugar beet breeding systems at Molo and Subukia. 2032 lb. of seed were supplied to the Pyrethrum Board.

Publications

Kroll, U.—The breeding of improved pyrethrum varieties. *Pyrethrum Post,* Vol. 4, No. 4.

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———— Some plant breeding aspects on pyrethrum. Paper read at Specialist Committee on Agricultural Botany, Njoro, September.

U. KROLL
Senior Pyrethrum Officer,

ANNUAL REPORT OF THE OFFICER-IN-CHARGE SISAL RESEARCH STATION, THIKA, 1958

Meteorological

RAINFALL AT THE SISAL RESEARCH STATION, THIKA

		Average previous 17 years
January	0·87″ in 2 days	1·23″ in 3·2 days
February	7·87″ in 7 „	1·14″ in 2·5 „
March	7·73″ in 6 „	3·15″ in 7·2 „
April	6·69″ in 14 „	8·76″ in 15·5 „
May	12·16″ in 19 „	4·63″ in 11·0 „
June	2·05″ in 11 „	0·98″ in 4·7 „
July	2·42″ in 10 „	0·50″ in 3·3 „
August	—	0·69″ in 4·7 „
September	—	0·69″ in 3·4 „
October	0·91″ in 6 „	1·79″ in 5·0 „
November	3·23″ in 11 „	5·55″ in 14·5 „
December	2·59″ in 11 „	3·22″ in 9·3 „
TOTAL	46·52″ in 97 days	32·33″ in 84·3 days

The average annual rainfall for the 18 years recording at the station, 1941-58, amounts to 33.01 in.

The rainfall for 1958 was the second highest recorded at this station in spite of the partial failure of the short rains.

The growth of sisal and vegetation was, however, well maintained during the whole year.

SALE OF FIBRE

The fibre produced at the station during 1958 amounted to 32,818 lb. of line fibre, 1,285 lb. brushed tow and 2,908 lb. flume tow which was sold locally and realized the sum of approximately £797, which was paid to the Kenya Sisal Board.

Investigational Work in Progress

NURSERY TRIALS

The fifth cycle of the Nursery Manurial and Mulching Trial was lifted in April, 1958, and significant increases in plant weight were obtained from sisal waste whether applied as a mulch or dug in and also from the nitrogen applications. The effects of P and K were non-significant. When sisal waste has been left on the surface as a mulch, a beneficial effect has only been observed in three out of the five cycles, whereas a consistently beneficial effect, cycle after cycle, has been obtained when it was dug into the top soil. An effect from N has been obtained in four out of the five cycles, while P has only been beneficial in one cycle and the K effect has been negative but non-significant in all cycles.

In the Nursery Nitrogen and Lime Trial the nitrogenous fertilizer having the biggest effect has been sulphate of ammonia, while the effect of lime has reduced the weight of the plants lifted in all three cycles.

No response to irrigation was obtained in the first two cycles of the Irrigated Nursery Trial. The trial is now in its third cycle.

Recommendations to date are thus restricted to the application of 30-50 tons of well rotted sisal waste per acre dug into the top soil with applications of sulphate of ammonia once or twice during the cycle at the rate of 300 lb. per acre.

No other nursery trials were lifted during the year. Two trials were planted to observe the effect of a wax emulsion spray, partly to prevent drying out of young plants and partly to protect them against possible ill effects of chemical weedkillers sprayed on to keep the nursery clean.

Demonstration of mechanical weeding implements in a nursery were made during the year and also a successful demonstration of the possibility of lifting the plants from the nursery by a conventional beet lifter. Both operations should simplify the work in nurseries and save a great deal of hand labour.

Planting Material Trials

The Planting Method Trial planted in April, 1949, was completed in January, 1958. The spacing was 12 ft. × 2 ft. 6 in. (1,452 plants per acre). The differences in the results between nursery plants and suckers of similar size when planted out were small. Young suckers, which were considerably smaller when planted out, took longer to reach a first cut and final poling.

The plants were planted deep or shallow, and although the deep-planted plants grew a longer leaf during the first 18 months this difference soon disappeared and the rate of leaf production was greater in the shallow-planted plants, this serves as a warning against planting too deep or throwing soil up against newly planted plants.

Grading from nurseries is obviously much easier than grading from suckers, but either can be used as planting material if the practice of grading is strictly adhered to.

The difference in leaf production between deep and shallow plantings was reflected in fibre yield, for in all cases the shallow-planted plots yielded more fibre, and also a smaller number of leaves was needed per ton of fibre produced.

Plant Management Trials

An investigation took place during the year into the annual rate of leaf growth per plant in all the external Plant Management Trials. It has, in the past, been assumed that sisal plants grew leaves at a steady rate of about 20-25 per year during the whole cycle of its life, but the investigation has shown that this is not the case. The plant appears to take about a year to establish a root system and get over the shock of transplanting, after which it produces a maximum number of leaves the following year, and thereafter a steadily decreasing number of leaves in every successive year until it dies.

How much the reduction in leaf count is due to cutting will be investigated in a trial to be planted in 1959, but with the evidence available it is fair to assume that the rate of leaf production per year is not constant, and this is an important factor to bear in mind when estimating yields.

The biggest factor influencing annual leaf increase is the population factor. This showed up in all five external trials in which the low populations produced leaves at a faster rate than the higher populations. This, of course, does not mean that more leaves were grown per acre as the greater number of leaves in the higher populations easily compensated for their slower rate of growth.

The cutting intensity is the second biggest factor influencing the rate of leaves grown. Since poling is delayed when only a small number of leaves are left after each cut, the plants cut heavily will, in later years, produce more leaves than the plants cut leniently as the latter pole out earlier. There is, however, little object in growing these extra leaves, as a shortening of leaf length is induced by the heavier cutting which means that more leaves are needed to produce a ton of fibre.

A delayed first cut will also induce a smaller total number of leaves per plant, and while the annual growth does not vary significantly according to when one starts cutting, a delayed first cut will, however, accelerate poling and will result in a smaller number of leaves grown per plant. It must be borne in mind that a first cut taken too early will induce shorter leaves to be grown so a mean has to be struck between many and short leaves at an early first cut, and fewer but longer leaves on a delayed first cut, which leads the station to recommend a first cut when the plants have grown 125 leaves, or, in faster growing areas, 100 leaves.

The Double *versus* Single Row Trial has clearly shown the speedier growth of the plants in the double rows, whatever the row spacing or population. The speedier growth is due to the greater distance between the plants in the rows, and is reflected in more leaves per plant, and more fibre per acre in any given time.

Cultivation Trials

The only cultivation trial in progress was cut out during 1958, and due to the high initial fertility, the variations were small between the treatments. The trial will be replanted.

Sisal growing on the crown of camber beds, interplanted with pineapples, was doing well, but only 22 per cent of the pineapples harvested exceeded 3 lb. The pineapples were growing on the sides of the beds, and it appears that too little is known as yet about the handling of this crop on black cotton soil.

Fertilizer Trials

Accelerated growth, due to some of the fertilizer treatments can be seen in all trials, but as the treated plots begin to pole out and the untreated plots continue to grow, the gap is likely to narrow.

The biggest effects are still those obtained from a sisal waste application which not only accelerated the rate of growth and produced more fibre per acre, but also grew a longer leaf, which is apparent in the smaller number of leaves needed per ton of fibre.

Beneficial responses from repeat-applications of sisal waste have been obtained in some of the trials, but the responses measured to date are smaller than the responses obtained from the initial applications prior to planting.

The responses to nitrogen applications in the form of sulphate of ammonia have also been significantly beneficial and, in some cases, as good as the results from sisal waste. It is interesting to see that whereas the response to sisal waste was an explosive increase in growth in the early years which petered out during the third year, the annual applications of nitrogen has meant a steady annual increase in leaf growth.

To apply sisal waste and nitrogen in combination appears to be the best recommendation one can make to date, and will be confirmed when cutting becomes more general, if the increase in fibre yields shows up in the same order as the leaf growth.

One new fertilizer trial was planted at Murera Sisal Estate, Ruiru, during 1958, testing sisal waste, nitrogen and lime.

Hybrid and Variety Trials

Eight hybrids are being compared with *Agave sisalana* and after fibre yields and leaf characteristics are compared, it would appear that at least five are not of commercial value. Three of the hybrids, plus others received after this trial was planted in 1952, warrant further study.

Herbicide Trials

The most promising herbicide under observation is still Dalapon, used as a control measure against *Digitaria scalarum*. The recommendations are that Dalapon be applied to the soil before planting of sisal, followed up by repeat applications at a lower rate.

Experiments with herbicides against broad-leafed weeds have, in general, been successful, but the absence of broad-leafed weeds encourages the annual grasses which may be equally strong, or more so, as competitors to sisal, so investigations are continuing with the object of finding a cheap control measure against annual grasses which will not adversely affect the growing sisal.

Compressed Soil and Sisal Waste Pots

In an endeavour to make sisal waste a revenue-earning factor, experiments were made during the year with a combined soil and sisal waste pot to be used for seedlings of various kinds and which could be transplanted. With a commercial machine costing less than £40, several thousand pots could be made per day. Using a combination of 60 per cent waste and 40 per cent soil, it was found that the mixture would make a pot capable of standing up to rather rough treatment. The suitability of the pots for various crops, vegetables, trees, etc., is at present under investigation. The revenue thus earned may conceivably go towards getting the remaining waste back to the field.

Publications

Lerche, K.—Agricultural machinery development as related to the sisal industry. Paper submitted to the Agricultural Machinery Conference, held at Muguga, 14th February, 1958.

———— Notes on the Conference on Agricultural Machinery Development, held at E.A.A.F.R.O., Muguga, on 14th February, 1958. *Kenya Sisal Board Bulletin,* No. 25, p. 22, July.

———— Recovery of flume tow. *Ibid,* p. 32.

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ANNUAL REPORT FOR IRRIGATION INVESTIGATIONS, 1958

Hola

Land use studies based on the 1957 findings were continued at Hola and field experience in the irrigation of the red desert hinterland soils was gained through the operation of the pilot scheme. Under irrigation these soils were found on a field scale, as on experimental plots, able to support good growth of cotton, groundnuts and soya beans. Also they yielded an 8.17 bags per acre crop of maize which made a worthwhile contribution towards local scheme labour ration requirements. On the other hand, the growth promise of the other crops did not go through to harvest. The cotton suffered an unexpected attack of American bollworm early in the season and this caused most of the early crop to be lost. Again, the needs of the ginnery handling the Hola cotton crop determined in large measure the variety which could be grown on the scheme and this was UK51. UK51 is bred for rain growing in areas of unreliable rainfall and under irrigation its early growth was prolific and leafy, the amount of leaf which the plant carried being much in excess of its normal characteristics under rain cultivation. Consequently, when irrigation was cut off in the hope that the moisture strain would force the crop into boll, the plant responded instead by wilting, and many of the late bolls failed to open properly. Additional factors concerned with the disappointing cotton yields obtained on the pilot scheme were poorness of the seed with the resultant poorness of stand, lateness of sowing with the resultant need for uprooting the crop in preparation for short rains plantings before the harvest was completed and uneveness of land surface resulting in uneveness of water application. Little over 630 lb. seed cotton per acre were taken from the pilot scheme compared with an average yield on the red soil experimental plots of 1,472 lb. per acre (maximum 2,823, minimum 625) and with an estimated yield at one stage for the pilot scheme of 1,200.

In like manner, because of poor germination, the average groundnut yield on the pilot scheme was 735 lb. per acre only, even though the yield per plant was very satisfactory. On the experimental plots the average was 1,620 lb. per acre (maximum 2,436, minimum 1,065). The soya beans on the pilot scheme were spaced too widely and, despite excellent vegetative growth, yielded only 400 lb. per acre.

Improved cultural practices based on 1958 experience are expected to lead to notable improvements in crop yields on field plantings. Meanwhile, the crop sequence which it has been decided to adopt will follow a six-phase rotation:—

SR (1)—Soya beans or groundnuts, Stover removed.
LR (2)—Cotton.
SR (3)—Soya beans or groundnuts, Stover removed.
LR (4)—Cotton.
SR (5)—Soya beans or groundnuts, Stover incorporated together with the Stover removed from phases (1) and (3).
LR (6)—Maize.

The object of the rotation is to achieve some nitrogen synthesis prior to the non-leguminous crop and to give the relatively small portion of maize included in the rotation the best possible opportunity of cropping in the face of local salinity by concentrating on the land in which it is to be planted as much readily decomposable organic material as the individual rotation units can produce. Pest control considerations determine that the maize and cotton be planted in the same season and that a close season be introduced. Further pest control measures which have been adopted include careful crop hygiene and elaborate insecticide application régimes. These measures kept at bay a large number of pests which

infest the proximity of the scheme and protected the crops from severe damage by them. Armyworm, cutworm, spiny bollworm, stalkborer, cottonseed bug, stainers, jassid, aphis, red spider mite and termites were present, but noteworthy damage was caused only by the unexpected attack of American bollworm on the cotton.

In view of the success with which crops grow on the red soil, reconnaissances were undertaken from the air and on the ground to determine the possibilities of extending irrigation in the desert hinterland on similar red soils and to find suitable land which could expeditiously be brought under irrigation from the existing pilot scheme main canal. The more extensive reconnaissances led to the delineation of some 30,000 acres which were considered worth further investigation. This area was examined by the engineers and selected parts were then reconnoitred further until they were narrowed down to a proposal to integrate a further 3,500 acres with the present scheme by pumping. The more local reconnaissance and a programme of trace cutting which went with it ultimately delineated about 1,500 acres of usable land which is suitably located for immediate development. Part of this area lay adjacent to the pilot scheme and part was separated from the pilot scheme by a strip of grey soil which experience at Hola has shown to be much less well adapted to irrigation. Of these 1,500 acres, 900 acres have been chosen for development for planting in 1959.

During the course of the reconnaissances it became apparent that the red desert soils tend to occur on the higher or more appreciably sloping land, while the grey soils, which we seek to avoid, tend to occur where the land is flat or slightly depressed. The red soils graded towards grey through yellowish-brown soils, the change sometimes being rapid but usually being gradual and difficult to detect. Areas of the most desirable red soils were found to be limited, but transitional soils, which experience on the pilot scheme had shown to be quite usable, proved to be fairly extensive. Concretionary laterite was found below three feet in some red soil situations, though the circumstances in which this develops remains to be verified. Where the laterite occurs the soils are considered susceptible to droughting, even though the salinity/alkalinity status is satisfactory; this is reflected to some extent in the changes in the composition of the vegetation supported.

Detailed experimentation on the red soil sought to continue observations on the reclamation measures initiated in earlier years and to investigate the fertility factor which the earlier work had indicated as being important.

In the reclamation investigations, lucerne and groundnuts alone of the crops tested benefited appreciably from leaching while none of the gypsum applications led to important increases in crop yields. Except on lucerne, the harmful effects of cambered bed cultivation recorded in 1957 were less apparent in 1958:—

Crop	Yield Units/Acre	Reclamation Treatments					
		Nil	Leached	Leaching + Gypsum			Cambered Bed
				2 Tons Gypsum	7 Tons Gypsum	20 Tons Gypsum	
Groundnuts ..	Lb. grain	1,236	2,042	1,634	—	—	—
Pigeon pea ..	Lb. grain	747	832	1,254	—	—	—
Maize	Lb. grain ..	1,266	1,342	1,422	—	—	—
		574	—	—	—	—	1,436
Cotton ..	L. seed cotton	1,900	1,990	1,837	—	—	—
		1,216	1,280	—	1,479	1,411	—
		2,322	—	—	—	—	1,915
Lucerne ..	Tons green matter	2·76	3·20	3·76	—	—	—
Napier grass ..		3·03	—	—	—	—	0·43
		22·3	25·1	24·6	—	—	—

Responsible to fertilizers in this and the other fertility trials on the red soils were variable, promising results being obtained under certain circumstances with maize, Napier grass, lucerne and jute but no consistent trends being discerned on groundnuts, pigeon pea or cotton:—

Crop	Yield Units/Acre	Leaching Treatment	Control	Fertiliser Treatment	
				Complete Seed Bed NPK with Urea top dressing	4 cwt.
Maize ..	Lb. grain	Nil Leached	963	1,569	—
			1,241	1,443	—
Napier grass	Tons green matter ..	Nil Leached	20·8	23·7	—
			20·6	29·7	—
Lucerne ..	Tons green matter ..	Nil Leached	2·46	3·09	—
			2·68	3·71	—
		Leached + Gypsum	3·42	4·10	—
Jute ..	Tons green matter	Nil	7·49	—	9·40

Cultural studies on cotton were continued and this showed that on 3-ft. rows, two plants per hill at 1 ft. 6-in. intervals was a suitable spacing for the varieties now under test, and that light waterings at 7-12-day intervals gave heavier yields and resulted in a smaller gross water consumption than five heavy waterings at 7-25-day intervals during the cotton season. At the same time, growth observations showed cotton to grow much better where the water was able to stand and soak into the soil than where it merely flowed past for a relaively short time during the irrigation. Adequacy of waterings had a distinctly greater influence on cotton yields than urea applications of 2 cwt. per acre spread over the growing season. Cotton varieties which had been bred by the Empire Cotton Growing Corporation for irrigation conditions yielded distinctly more heavily than UK51, even though these were longer-term cottons, and it was necessary to discontinue irrigation before they had matured a full crop:—

	Variety	Yield lb. Seed Crop/Acre
Sudan	X1730A	1,668
	BARXL1 ..	1,562
	BARXL3 ..	1,259
	UK51	1,089

The new varieties were efficient fruiters, carried much less leaf than UK51 and were correspondingly the easier to spray.

The changing range of crops was kept under observation, those showing a poor adaptation to local conditions in earlier years being dropped and new introductions being brought in. The main 1958 introductions were tropical and sub-tropical tree crops, the majority of which were successfully established, and a number of new varieties of maize, soya bean, sunhemp and castor. No startlingly new crops were found but finger millet, bulrush millet, several fodder grasses, most legumes, jute, sunflower, cotton and cassava grew and yielded satisfactorily.

The impermeability of the grey soil led to waterlogging of low spots and to the development of intense alkalinity on their fringes. Such water logging was particularly severe near the more frequently water-carrying canals. On the other

hand, green manure to improve the permeability of these soils was startlingly beneficial on crops of maize and cotton if not on rice:—

Crop	Yield Units/Acre	Treatment without green manure	Leaching with green manure
Cotton	lb. seed cotton ..	754	1,344
Maize	lb. grain	1,000	1,753
Rice	lb. grain	3,297	2,828

Leaching after Gypsum application and green manure incorporation gave a maize grain yield of 2,090 lb. per acre. Again, where the water table was kept down and development of surface alkalinity avoided by judicious water application and by the provision of intensive drainage (in this circumstance through the use of cambered beds) a yield of 3,497 lb. seed cotton per acre was obtained on grey soil which had been continuously and intensively cropped for 2½ years without prior reclamation treatment. Sunflowers, cow peas and pigeon peas also grew satisfactorily on this soil.

In view of the low permeability of the grey soils, their possibilities for fish farming with *Tilapia, nigra* and *T. mozambica* in shallow ponds are being explored. The ponds quickly attracted fish-eating birds and the protection of the fish from their depredations remains to be achieved.

Laboratory investigations in association with the land reclamation studies were continued in 1958 but the data is not yet assembled for presentation.

Irrigation Research Station, Mwea

Weather Conditions

The total rainfall for the year at 45.67 in. was the highest for the three years for which reliable records are available. Monthly and annual totals in inches are given below for 1956, 1957 and 1958.

	1956	1957	1958
January	2·12	5·30	0·95
February	0·21	0·61	1·68
March	0·78	1·95	1·43
April	14·03	12·54	8·22
May	2·85	9·17	13·78
June	0·25	0·56	0·64
July	0·00	0·34	1·86
August	0·70	0·09	0·13
September	0·25	0·69	0·08
October	1·70	1·66	1·93
November	6·40	7·84	10·34
December	0·89	1·16	4·63
Total	30·18	41·91	45·67

Rainfall intensity, air temperature and evaporation records were kept throughout the year and a sunshine recorder was installed towards the end of the year. The latter is mainly for use in investigations into sterility in long rains rice.

Rice

Rice Varieties

The variety collection which was started in 1956 was continued with the addition of seven varieties from Persia, one from Nyasaland and three from Surinam. By the end of the year the collection numbered 84 varieties. So far there is insufficient evidence to consider replacing Sindano as the standard variety in the area. Although several other varieties such as Siam 29 have a slightly higher yield potential than Sindano, they take about two months longer to mature and are more difficult to harvest because of their excessive straw production.

Rice Fertilizer and Spacing Experiments

The fertilizer trial which was started in 1957 was completed in the long rains, 1958. In its third season it showed that on fields which had suffered excessive loss of top soil from levelling and bunding, plots which had received no phosphate were unable to resist the regular leaf miner attacks and yielded practically nothing.

A new fertilizer trial was started in the long rains, 1958, on a larger field where the minimum of top soil movement had been incurred in levelling and bunding. Sulphate of ammonia and double superphosphate were each applied at three rates of application (nil, 1 cwt. and 2 cwt. per acre) just before transplanting. There were also three spacing treatments, namely 6 in. × 6 in, 9 in × 9 in. and 12 in × 12 in., and the design was a 3^3 factorial with two replications. Overall mean yield was high, over 4,200 lb. (26.5 bags) of paddy per acre. Although neither of the two fertilizers produced a significant effect on yield, there were strong indications of a yield response to the 1 cwt. level of each of them. After the long rains harvest the crop was ratooned without reapplication of fertilizers, and harvested again after two and a half months in October just before the short rains. Mean yield of the ratoon crop was 2090 lb. (13.1 bags) of paddy per acre. There was a significant residual effect of the 1 cwt. rate of double superphosphate but no residual effect of sulphate of ammonia. As regards spacing, the long rains crop showed a highly significant and progressive yield increase the closer the spacing, but in the case of the much lower yielding ratoon crop, although the closest spacing still gave the highest yield this was not significant. In the 1957 spacing trial very similar results were obtained in the short rains of that year although, in the long rains, the yield advantage of 6 in. × 6 in. spacing compared with 9 in × 9 in. was not significant. But it seems quite clear from both experiments that 12 in. × 12 in. is too wide for Sindano in this area.

An experiment started in the long rains, 1957, to compare various times of application of sulphate of ammonia was completed in the short rains of that year. In the long rains there had been no response to sulphate of ammonia at all. In the short rains the treatments were, of course, reapplied as before and this time there was a response to sulphate of ammonia, but no significant differences between the various times of application. As the most convenient time for applying fertilizer is just before transplanting, there seems no evidence to warrant altering this practice in the case of sulphate of ammonia.

Water Requirements of Rice

In 1957 an investigation was started to determine the total quantity of irrigation water required to grow a rice crop. This is being done by direct measurement through a Kents Torrent meter of the actual water applied to the field between transplanting and harvesting and, therefore, does not take account of transmission losses in canals or of water used in the rice nursery, but includes the water used in preparing the field before transplanting. In considering the

results it must also be realized that there was no drainage from the field except just before harvest: water was simply added when necessary to keep the ponded level in the field at about 3 in. In the long rains, 1957, 17 in. of irrigation water were used and rainfall during the crop totalled 22.5 in., giving a total water usage of 39½ in. No results were obtained in the short rains, 1957, or the long rains, 1958. In the short rains, 1958, irrigation water used totalled 16.3 in. and rainfall 17.1 in. making a total of 33.4 in. The rice variety in each season was Sindano, which requires 4¼-4½ months from transplanting to harvesting.

Rice Mechanization

A one-acre field of Sindano was drilled by a Ferguson multipurpose drill in a dry, friable tilth at the start of the long rains and germinated by rain. Unfortunately, germination was very uneven, due to waterlogging caused by a combination of heavy rain after sowing and the fact that the subsoil was already wet from recent levelling. After establishment, the crop was irrigated in the normal way until about three weeks before harvesting. Due to uneven stand yield was only 12 bags per acre compared with about 25 bags per acre on adjacent transplanted fields. Drilling of rice is, however, considered sufficiently promising to justify further work on the subject in 1959.

Combine harvesting was tried on several fields of Sindano and Siam 29. This was possible through the generous co-operation of Messrs. Farm Machinery (Distributors) Ltd., who loaned a M.H. 735 self-propelled 5 ft. 9 in.-cut machine for these tests. The results were, in general, most successful. Although at high drum speeds considerable grain breakage and dehusking occurred, this damage was reduced to a negligible amount by reducing drum speed. Little or no whole grain passed out with the straw after the fan had been suitably adjusted. The Siam 29 was a very dense-strawed crop, but by taking a high cut of about 10 in. the machine seemed to have no difficulty in dealing with it. The grain, however, contained appreciable quantities of chaff, etc., and required rewinnowing before it could be sold. The rate of work was about ½ acre per hour. The fields had been thoroughly dried off by draining three to four weeks before harvest, so no special wheels or tracks were needed on the combine, and only very short sections of bund and drain needed to be levelled to get the combine into each field.

Other Crops

Observation plots of a number of alternative crops to rice were continued during the year. Most annual crops other than rice have been found difficult to irrigate on the black soil but some success has been achieved with sugar cane, sunflower, onions and clitoria fodder. Several annual crops did well, sown on the flat just before the rains, without irrigation. These were sorghum, sunn hemp and chick pea. Work on fish (*Tilapia nigra*) as an alternative crop to rice started towards the end of 1957 in co-operation with the Chief Fisheries Research Officer of the Game Department, and early results are quite encouraging.

Red Soil Irrigation

Two main methods of irrigating the red soil were employed throughout the year. These were level contour terraces of about 1½ acres each, and inclined furrows. The level contour terrace method consists basically of ponding water in flat field furrows separated by ridges on which the crop is grown. Owing to the very high permeability of this soil, it was found necessary to use a flow into the field of at least 1½ cusecs and preferably 2 cusecs and to have the field furrows as widely spaced as possible if the water was to pass evenly along all the furrows in a reasonable time without excessive consumption of water. Also the field must, of course, be very accurately levelled if economic, even watering is to be achieved.

The method was found to be quite satisfactory for wide-spaced crops like melons, cucumbers, sugar cane, napier grass, cotton, asparagus and tomatoes but unsuitable for close-spaced crops except those with a deep rooting system such as lucerne and hibiscus, provided these are planted in a rainy season for germination and establishment. The inclined furrow method of irrigation is suited to crops requiring a closer spacing of about 1½-2 ft. between the rows, such as pulses, sorghum and most vegetables. This method is also convenient for very small areas of any crops because each furrow can be watered independently by a syphon from the feeder canal.

Observational work was continued throughout the year on numerous possible cash crops for the red soil. New crops are usually planted in the nursery if seed is very limited, or else in the inclined furrow area for initial observation and bulking. Those showing sufficient promise are then planted on a larger scale in a level contour terrace field if suited to that method of irrigation. The most promising crops so far are hibiscus, tomatoes, asparagus, lucerne, sugar cane, melons, cucumbers, soya beans and chillies. Experiments on arabica, robusta and excelsa coffee and on various tree fruits have been planted but it is too early to comment on these yet.

Hibiscus Cannabinus

The trials on this potential source of jute substitute fibre for sack making were started in 1956. In the first two years most of the trials were on black cotton soil and resulted in failure to produce an economic yield of fibre. Even with fertilizer, yields were only about 400 lb. of clean, dry fibre per acre. Late in 1957 an observation trial of the Nigeria variety was planted on the red loam soil. This grew through the dry season of 1957/58 and relied mainly on irrigation. It was not fertilized except for a top dressing of sulphate of ammonia at 1 cwt. per acre two months after planting. The yield of clean, dry fibre after a growing period of 115 days was just over 600 lb. per acre, still a very low yield for a fibre crop of this type.

In the long rains, 1958, two new hibiscus experiments were done on the red soil, a variety trial of all available varieties, and a fertilizer and spacing experiment. Both were planted in early May and so had the benefit of ample rainfall for germination and establishment. These trials are reported below.

Hibiscus Variety Trial

In this trial, which was not fertilized, the varieties E.C.R. 986, Nigeria, E.C.R. 985 and Kitale all yielded over 800 lb. per acre and were significantly better than the remaining four varieties: Florida B.6-52-1, Cuba 108, Cubano and Florida B.6-52-41, which all gave less than 600 lb. Fibre quality tests, which were kindly done by Messrs. E.A. Bag & Cordage Ltd., Ruiru, showed that the best quality fibre was produced by E.C.R. 986 although E.C.R. 985, Nigeria and Kitale were also quite satisfactory. The four low-yielding varieties, however, were of comparatively poor quality, containing many weak fibres. E.C.R. 986 and E.C.R. 985 are Sudan varieties and, although high yielding, they were much slower growing than Nigeria and Kitale which is a factor against them. They were, however, comparatively resistant to leaf mildew which usually attacks the quicker growing varieties in this area, although Nigeria also showed appreciable resistance to this.

Hibiscus Fertilizer and Spacing Experiment

This experiment was to test the effect of sulphate of ammonia and double superphosphate, each at three rates, on fibre yield of E.C.R. 985, and to compare three different spacings, namely 8 in. × 8 in., 8 in. × 4 in. and 8 in. × 1 in. The

design was a 3^3 factorial with a single replicate. The 1-cwt. rate of sulphate of ammonia increased the yield very significantly from 865 lb. to 1,313 lb. of dry, clean fibre per acre but the small extra yield increase by the 2-cwt. rate of this fertilizer was not significant. There was no significant response to double superphosphate. Of the three different spacings, the best yield was given by the 8 in. × 4 in., although it was not significantly better than the others.

Cotton Varieties

In the 1957-58 season, six varieties of cotton were compared for yield in a randomized block variety trial on the red soil. The trial was planted on 29th July, 1957, on irrigation, and harvested between 4th March and 28th April, 1958. Cotton stainers, one of the worst pests of cotton in this area, were fairly adequately controlled throughout the season by heavy dusting with 5 per cent D.D.T. whenever the pest built up to appreciable numbers. The two Egyptian varieties, Bar XL3 and X1730 A, each yielded around 1,130 lb. of "A.R." seed cotton per acre, which was very significantly higher than the four American varieties. The latter were UK51, Albar, BP52 and Wilds, whose yields were between 400 and 600 lb. per acre, and were not significantly different from each other.

Unirrigated Maize Manurial and Spacing Experiments

These experiments were started in the long rains, 1958, to obtain information on the cropping potential of the red soils on rainfall alone, particularly in view of the large areas of rain-grown maize being tilled by Africans in unirrigated red soil areas of Mwea/Tebere.

The manurial experiment was a 3^3 factorial with single replicate to test the effect on yield of farmyard manure at 0, 5 and 10 tons per acre, sulphate of ammonia and double superphosphate each at 0, 1 and 2 cwt. per acre. The farmyard manure was spread and dug in and the phosphate placed in the planting holes before planting. The sulphate of ammonia was applied as a top dressing seven weeks after planting, placed beside each plot and covered. The experiment was planted on 31st March, harvested on 4th September, during which time the rainfall totalled 24.6 in., virtually all of which was during the first seven weeks. The mean yield was 2,393 lb. (12 bags) of dry grain per acre. The only response was to farmyard manure, the 5-ton rate of which significantly increased the yield from 10.4 bags to 12.2 bags per acre, but the smaller additional increase from the 10-ton rate was not significant. The lack of response to sulphate of ammonia on this soil was unexpected and can only be attributed to lack of rain after it was applied. The lack of a phosphate response was in line with other results on this soil.

In the maize-spacing experiment which was planted and harvested at the same time as the manurial experiment, five different spacings were compared in a 5 × 5 latin square. The spacings were 3 ft. × 1 ft., 3 ft. × 2 ft., 4 ft. × 2 ft. 5 ft. × 2 ft. and 6 ft. × 2 ft. There was a general increase in yield the closer the spacing. The closest spacing, 3 ft. × 1 ft., significantly outyielded the three widest spacings and the 3 ft. × 2 ft. gave a significantly higher yield than the two widest spacings. The season was probably a better one than usual for rain, although only three years' reliable records are available. A secondary comparison of interplanted beans versus nil, applied to split plots, had to be abandoned owing to severe bean fly attack.

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Agricultural Officer (Irrigation Research).

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH) COAST PROVINCE, 1958

Weather

Over most of the Province the long rains started late and continued through June until mid-August after which time no effective rain was received. At Matuga the total for the year was 34.52 inches, 29.99 inches falling between mid-March and mid-August. This rainfall was adequate for most annual crops, but longer-term crops such as castor and cassava were badly stunted.

Investigations

During the year exploratory fertilizer trials in the districts have been started on the same basis as elsewhere in the Colony. The results of these trials are discussed by the Senior Soil Chemist in his report.

A diversification of the investigations at Hola has brought these trials within the responsibilities of the Agricultural Officer (Research), Coast Province. Those trials covering land use and reclamation at Hola are reported by the Senior Soil Chemist.

Cotton Variety Trial, Msabaha

With no new varieties the trial was a straight comparison of UK51 and UK55. The difference between these two cottons is slight and even in a year of poor rainfall, when UK51 may be expected to do better than UK55, the difference did not reach significance.

TABLE I—MEAN YIELD OF SEED COTTON IN POUNDS/ACRE

U.K. 51	U.K. 55	L.S.D. P = 0·05
1,026	981	± 190·7

C. of V. = 25·2%

There was no difference between the varieties in percentage of A.R. Grade Cotton.

Cotton Dates of Planting Trial, Msabaha

In last year's report on this trial it was suggested that there was a depression of yield on the earliest planted cotton by insect attack that was escaped by the later plantings. To check this two trials with the same dates of planting were laid out; one trial to be sprayed, the other not.

The dates of planting with (in brackets) the rainfall the cotton received during its growing season, were: A. 2/5/58: (25.62 inches), B. 13/5/58: (23.71 inches), and C. 29/5/58: (20.52 inches). The variety was UK51.

TABLE II—MEAN YIELDS OF SEED COTTON OF U.K. 51 IN POUNDS/ACRE

PLANTING DATES	A	B	C	L. S. D.		
				5%	1%	0·1%
Unsprayed ..	922·5	825·8	590·2	176·71	243·5	334·7
Sprayed	1,155·1	889·8	678·5	137·6	189·6	260·6

Although a statistical comparison between trials has little value the benefit from spraying the earliest planting is very apparent. In fact the small difference between sprayed and unsprayed later-planted cotton is remarkable. Further

benefits from spraying the cotton were the much higher proportion of A.R. Grade cotton, 71 per cent, the fortnight earlier maturity and the much greater weight of the crop picked in the first month.

Cotton Spacing Trials

Two identically designed trials on the spacing of cotton were conducted during the year: one under irrigation at Hola and the other rains-grown at Msabaha.

The spacings were:—

A. 3′ × 2′: 2 plants per hole, 14,520 plants/acre.
B. 3′ × 1½′: 2 plants per hole, 19,360 plants/acre.
C. 3′ × 1′: 2 plants per hole, 29,040 plants/acre.
D. 3′ × 1′: 1 plant per hole, 14,520 plants/acre.
E. 3′ × ¾′: 1 plant per hole, 19,360 plants/acre.

The variety at both sites was UK51 and each trial was sprayed against insect pests.

Table III—Yield of Seed Cotton in Pounds/Acre

Spacing	A	B	C	D	E	S.E.
Hola	1,119	1,624	1,091	1,246	1,001	±169
Msabaha	1,084·3	1,068·8	1,101·9	1,060·2	1,125·3	± 50·7

The range of spacings was not sufficiently wide to reach the limits when larger crops per plant fail to compensate for wider spacings or when overcrowding reduces the overall crop.

The comparatively small difference between the rains-grown cotton and the irrigated is striking and may be due to the very vigorous vegetative growth of UK51 when irrigated.

Cotton Variety Trial, Hola

As indicated in the preceding trial UK51 is not a very suitable cotton under irrigation at Hola. To find an alternative the following varieties were compared with UK51 as control:—

Sudan × 1730A,
Bar × L1,
Bar × L3.

Table IV—Yields of Seed Cotton in Pounds/Acre

Sudan X1730A	Bar XL1	Bar XL3	U.K. 51
1,668	1,562	1,249	1,089

L.S.D.	5%	1%	0·1%
—	± 241·5	± 366	± 588

Although Sudan × 1730A and Bar × L1 are considerably better than UK51 in this trial, the results do not give a true comparison of the merits of these cottons. Due to a policy decision for the main pilot area, water was turned off just when the longer term Sudanese cottons were setting the better part of their crop, resulting in a loss of a considerable number of immature bolls.

Times and Rates of Nitrogen Application to Sorghum, Matuga

This was an elaboration of the times of nitrogen application to sorghum trial in last year's report. The following dressings of Sulphate of Ammonia were compared against control using six randomized blocks of six plots.

A. No Nitrogen.

B. 1 cwt. per acre; ½ at planting, ½ after considerable rain.

C. ½ cwt. per acre in 4 weekly dressings.

D. ½ cwt. per acre in 4 fortnightly dressings during the rains.

E. 1 cwt. per acre in 4 fortnightly dressings during the rains.

F. 1 cwt. per acre applied ½ at a fortnight after germination and the second ½ one month later.

The site of the experiment was on land broken from a lengthy period of grass fallow. Due to very dry conditions the land was not ploughed until immediately before planting. This affected the results, the breakdown of organic matter causing considerable nitrogen shortage in most treatments.

TABLE V—MEAN YIELD OF T.A.D.A. SORGHUM GRAIN IN CWT./ACRE

A	B	C	D	E	F	L.S.D. at 5%
6·59	10·44	10·08	9·93	9·90	8·56	± 2·62

All treatments except F out-yielded control but with little difference between rates and times of application. From practical considerations the split dressing, ½ at planting, ½ as a top dressing still seems to be the best, possibly reducing the amount to ½ cwt. in all.

The degree of depression on yield when sorghum is grown immediately after a fallow can be judged by comparing these results with those obtained from the old times of nitrogen trial which was repeated on the same site as last year.

TABLE VI—MEAN YIELD OF T.A.D.A. SORGHUM GRAIN IN CWT./ACRE

A	B	C	D	E	SE
24·40	21·35	25·45	22·41	21·94	± 1·2 cwt.

A. No Nitrogen.

B. 1 cwt. of sulphate of ammonia/acre applied at planting time.

C. 1 cwt. of sulphate of ammonia/acre: ½ at planting, ½ after considerable rain.

D. 1 cwt. of sulphate of ammonia/acre applied after considerable rain.

E. 1 cwt. of sulphate of ammonia/acre in weekly applications for 5 weeks after planting.

Yields are over twice those of the preceding trial. The small difference between control and the other treatments is possiby due to the lack of heavy rain in early May which normally causes temporary water-logging and nitrogen deficiency in most years.

Fertilizer Trial on Cotton, Msabaha

As a result of pot tests on soil samples sent to Scott Laboratories the following treatments were applied to cotton in a 25 factorial.

A. ¾ cwt./acre of Urea.

B. 1 cwt./acre double superphosphate.

C. 2 cwt./acre gypsum.

D. 20 lb./acre manganese chloride.

E. A mixture of 5 lb. zinc chloride, 20 lb. borax, 6 oz. sodium molybdate and 15lb. cupric chloride per acre.

The variety of cotton was UK51 and the trial was sprayed with Endrin four times at 10-day intervals.

TABLE VII—YIELDS OF SEED COTTON OF U.K. 51 IN POUNDS/ACRE

TREATMENT	Yield per Acre in Pounds
¾ cwt./acre urea	1,388·3
Nil	1,230·9
1 cwt./acre double-superphospate ..	1,339·6
Nil	1,278·8
2 cwt./acre gypsum	1,344·1
Nil	1,274·3
20 lb./acre manganese chloride	1,321·6
Nil	1,296·0
Trace element mixture	1,290·9
Nil	1,327·5

S.E. ± 32·64 lb.

L.S.D. between means at p = 0·05 = ± 99·72 lb./acre.
p = 0·01 = ± 139·05 lb./acre.
p = 0·001 = ± 194·87 lb./acre.

The increase of 158·2 lb. of seed cotton from ¾ cwt./acre of Urea was significant at p = 0·01. 75% of the cotton was A.R. Grade.

R. H. BENNISON,
Agricultural Officer (L.H.P.) Coast Province.

ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), RIFT VALLEY PROVINCE, 1958

Weather

COMPARATIVE RAINFALL FIGURES

	1954	1955	1956	1957	1958
Nakuru	42·80	37·58	39·54	38·36	48·43
Njoro	46·48	38·92	42·31	31·98	51·70
Rongai	45·08	25·36	39·76	45·22	48·11
Molo	—	45·99	46·89	44·43	50·22
Kitale	47·91	40·12	45·01	40·27	56·91
Eldoret	38·13	39·79	43·95	31·95	55·26
Ol Joro Orok	36·79	35·28	40·96	39·22	49·02
South Kinangop previous 6 years' average ..	—	34·43	42·10	54·25	50·80

Nakuru District.—The rains commenced rather early and planting generally was earlier than usual, particularly in the lower areas. In general the total rainfall for all areas was above average, with a dry spell in the month of June.

South Kinangop.—Once again a wet year has prevailed with over 50 inches at the Station site. Unseasonal rain in February and March (16.30 inches) spoiled the harvesting of 1957-1958 crops and delayed planting. Surface drainage systems have allowed crops to make good recoveries.

The long rains were comparatively light except in the extreme north of the district, but wet weather continued in general until well into August. After a dry period the short rains started early and continued late. Temperatures have been lower and with much overcast weather, resulting in lower evaporation rates in the middle of the year.

Eldoret.—Rainfall for the year is 39.51 inches against a 40-year average of 40.89 inches. The first three months experienced better rains than usual. From April until October distribution was spasmodic which made planting difficult. Unseasonal rain in December proved valuable to dairy farmers.

Ol Joro Orok.— In early 1958 considerable unseasonal rainfall hindered the harvest of the 1957 planted crops, and weed and volunteer growth was greater than normal. Further heavy rainfall in May and June curtailed the planting programme for the district. The heavy rain continued up to the end of September, followed by a virtual drought and then heavy storms in early December.

Kitale.—Rainfall for the year was 11.55 inches above the 20-year average. Rainfall in April was later than usual and abnormally heavy, which caused difficulty and uncertainty with regard to maize planting. Early planting again paid dividends, and the season has been favourable to maize with a relatively dry spell in May which checked weed growth, followed by plenty of rain well distributed.

Experimental Work

Full details of cereal observation, fertilizer and variety trials can be found in the Annual Report of the Senior Plant Breeder.

Results of entomological trials can be found in the Annual Report of the Senior Entomologist.

Nakuru District

Cotton.—In an attempt to find an alternative crop in the Kampi-ya-Moto area, two cotton varieties, S.47 and U.K.51, were planted in 1958. To date over 500 lb./acre of seed cotton has been picked off each variety. It appears that some form of rainfall conservation is necessary to grow the crop in dry years. Water conservation plus insect control and fertilizers should allow yields to be increased considerably, and the 1959 trials will be aimed in this direction.

Ley Establishment.—Work in the district has shown conclusively that below 7,000 ft. direct sowing of a grass ley is superior to undersowing with any of the cereal crops, although results are less noticeable in the second and third years of the ley.

In a dry year, when there is competition for soil moisture, direct sown leys show up even better than undersown leys. If, however, leys must be sown on economic grounds, then the trials have shown that oats at 5-15 lb./acre lightly grazed off before the flowering stage do least damage to the ley.

There appears to be little to choose between broadcasting and drilling grass seed. There is, however, a slight tendency for broadcasting to favour germination in the case of Rhodes or Setaria seed. If planted deeper than $\frac{1}{4}''$, germination is reduced.

Rolling before or after planting the grass seed gives a better stand and consequently a higher first-year yield. This applies to direct or undersown leys. The trials have shown the importance of having germination tests made on the seed prior to planting. The best experimental leys have been produced with a seeding rate of 1-1$\frac{1}{4}$ lb. of pure germinating seed per acre.

Trace Element Trials.—As far as clovers are concerned, the chemists believe that various trace elements are lacking for optimum growth. Three large-scale trials were laid down in 1958 in an effort to determine the trace elements needed. No significant responses resulted from trace element applications based on pot-test laboratory findings. The whole question of field-scale follow-up trace element trials is being reviewed for the 1959 season.

Dry Season Fodder Crops.—Two dry season fodder trials were laid down at Kampi-ya-Moto: one, a comparison between Sudan grass, Panicum maximum var. Sigor, Napier Cameroons and Napier Ghana, the other between three varieties of sorghum, namely Kavirondo, Ambercane and Columbus grass. The two trials each had 100 lb. of superphosphate per acre.

The outstanding fodder of the seven varieties was Napier Ghana, which gave nearly twice the yield of green matter compared with any of the others. Of the sorghums, Kavirondo gave the highest yield.

Potatoes.—A potato variety trial was laid down at Dundori to compare Dutch Robijyn with several imported Dutch varieties. All varieties received 400lb. superphosphate, 200 lb. sulphate of ammonia, and 150 lb. muriate of potash per acre.

VARIETAL YIELDS IN TONS/ACRE

Voran	11·8	C.53	10·2
Prof Brockema	11·4	Robijyn	9·6
Profyt	11·1	Pimpernel	8·4
K.52	10·7	E.52	5·5

LEAST SIGNIFICANT DIFFERENCE

5% = 1·75 tons
2% = 2·10 tons

Using Dutch Robijyn as control:—

Voran gave a significantly higher yield at the 2 per cent level.

Prof Brockema and Profyt gave a significantly higher yield at the 5 per cent level.

E.52 gave a significantly lower yield at the 1 per cent level.

South Kinangop

Potato Trials.—Four potato fertilizer trials have been completed during 1958. Dutch Robijyn has been used as the test variety throughout. Trial 1 compared NPK as single fertilizers and in various combinations with a further comparison between new seed and old (chitted) seed. Results were as follows:—

FERTILISER	AVERAGE YIELDS	
	New Seed	Old Seed
	tons/acre	*tons/acre*
P	5·9	12·2
K	4·6	14·0
N	6·7	10·8
PK	6·2	13·0
PN	7·8	13·0
NK	6·2	13·3
PNK	8·3	16·2
Control	4·2	9·2

P = 42% superphosphate at 1 cwt./acre.
N = Sulphate of ammonia at 1 cwt./acre.
K = Muriate of potash at 1 cwt./acre.

All three fertilizers had beneficial effects with yield increases of about 20 bags/acre resulting from 1 cwt. sulphate of ammonia and from 1 cwt. triple superphosphate and about 10 bags/acre from 1 cwt. muriate of potash. Of great interest is the yield differences between "new" and "old" seed. This is presumably due to frost cutting down the "new" seed growth at its maximum. Although planted at the same time the new seed growth was 7-8 weeks behind that of the old seed.

The other three trials can be summarized by stating that the best apparent fertilizer mixture for potatoes on rich land on the Kinangop is:—

1½ cwt./acre sulphate of ammonia.

1 cwt./acre triple superphosphate (42 per cent P_2O_5).

1½ cwt./acre sulphate of potash.

On poorer land the rates would have to be increased proportionately.

Ronpha Grass Observation Trial.—An observation plot was planted in November, 1957, and a mixture of 1 cwt./acre (42 per cent) superphosphate, 1 cwt. sulphate of ammonia and 1 cwt. muriate of potash applied as a top dressing. Three cuts representing a year's growth were made, and the total yield obtained was equivalent to 47 tons of green material per acre.

Eldoret

Residual Trials.—The two long-term phosphate residual trials were continued to determine the effects of Uganda rock, soda phosphate and superphosphate applied in 1952, 1953 and 1954. Yields of wheat have been declining each year and are totally uneconomic save where additional superphosphate is applied annually. There appears to be no residual effect now from the original fertilizers and the trials illustrate the danger of omitting regular applications of phosphate on the specific soil type. These trials are now completed.

Organic Manures.—The experiment begun in 1957 to compare manure at 10 tons/acre from pigs, open cattle yards, covered cattle yards and superphosphate at 200 lb. per acre was continued, to observe any residual effects. Last year the pig manure was strikingly superior, and the yard manures slightly superior to the heavy superphosphate dressing.

Pig manure is again the best treatment where residuals on a test crop of barley are concerned, followed by the superphosphates, with the yard manures only slightly better than control.

Trace Element Trials.—Trials involving the major fertilizers and seven minor elements were planted at Kipkabus and Elgeyo border, using wheat, oats, grass and lucerne as indicator crops. Weed competition was excessive and no visual differences due to the treatments were apparent, despite the fact that laboratory soil analysis had shown deficiencies. These trials in conjunction with all other trace element trials in the province are under review at present.

Fertility Building.—Three forms of green manuring were compared on a field scale with the standard practice of 100 lb./acre basal double superphosphate. Treatments and yields were (*a*) sunflower and lupins ploughed in with 150 lb./acre basal double superphosphate—yield 12.3 bags of barley per acre; (*b*) sunflower and lupins ploughed in with 100 lb./acre basal double superphosphate—12.1 bags/acre; (*c*) oats grazed and ploughed in with 100 lb./acre basal double superphosphate—12.0 bags/acre. Control yielded 9.3 bags/acre. Each treatment gave an increase in yield of barley of some 30 per cent over control.

Alternative Crops.—All varieties of fodder beet and mangolds under test were complete failures. Three types of kale were grown of which Thousand Headed and Marrow Stem were quite successful. Rape was successful at the second attempt. Edible canna is grown on a farm scale. Three castor bean hybrids were satisfactory. Sesamum Angolense did not germinate.

Livestock

Pigs.—The third and last phase of the pig-feeding and housing trial was completed and a summary of complete costings is given below. Down-grading was shown to be the first cause of low profits, followed by poor conversion ratios, and in connexion with these observations the strain (or family) of pig appears to be the most important factor in bacon production. This is illustrated well by the fact that from 72 pigs the gross return/pig varied from Sh. 159/50 to Sh. 288/75 and that pigs returning Sh. 159/50 and Sh. 283/50 were found in the same treatment. Pigs fed *ad lib* mature for bacon some 1-2 weeks earlier, have poorer conversion ratios and are less profitable. Pigs reared outdoors mature for bacon some 2-3 weeks earlier. In this table total return is shown at 100 per cent payment.

Brief Summary of Costings Table

Treatment	Total Cost	Total Return	Days Weaning to Bacon wt.	Conversion Ratio	Profit/ Pig
(*a*) Outdoors to bacon wt. controlled feeding	196·66	256·83	129	3·17:1	60·17
(*b*) Indoors to bacon wt. controlled feeding	217·15	258·64	150	3·53:1	41·49
(*c*) Outdoors to bacon wt. *ad lib* feeding	218·77	256·55	124	3·76:1	37·78
(*d*) Indoors to bacon wt. *ad lib* feeding	218·51	255·54	137	3·58:1	37·03
(*e*) Outdoors/Indoors from 150 lb. wt. controlled feeding	198·54	262·56	134	3·17:1	64·02
(*f*) Outdoors/Indoors from 150 lb. wt. *ad lib* feeding ..	211·50	248·52	124	3·58:1	37·02
Average for all groups (72 pigs)	210·19	256·44	133	3·47:1	46·25

A new trial has been begun to compare meat meal and separated milk as sources of protein in pig feeding. The milk has been definitely superior and the pigs on meat meal (Grade B) have been very unthrifty. This is not due to protein deficiency. Work is continuing with the co-operation of E.A.A.F.R.O. to discover the exact cause. Amino-acid deficiencies are suspected.

Sheep.—Time of lambing: lambing is probably better before or at the beginning of the rains than at the end, due to the severe shortage of keep in the dry season.

The Corriedale ewes were on a good clover ley throughout most of the rains, April-October, and were in extremely good condition at the end of that season. They produced an average fleece of 8½ lb. in September, compared with 6½ lb. in 1957.

Two groups of six lambs were selected on 14th September, 1958, from Hampshire × natives born November, 1957, to March, 1958. The lambs had spent the previous five months on a ley in which the growth was 90 per cent white clover and 10 per cent Rhodes grass. During the finishing period of 10 weeks one group remained on the clover and the other was hurdled and moved daily on rape and finally on kale (for one week) in the experimental area. At the beginning of the period the lambs were in good condition, ready for finishing and, it was hoped, fattening into Highland lamb.

	Live wt. 14·9	Live wt. 24·11	Dead wt. 25·11	Grading	Killing Out Percentage	Average Payment Received
						Sh.
Clover group	54	68	27·3	1 H. lamb 5 Grade A	40·1	42·64
Rape group ..	52	63	30·7	6 Grade A	48·7	52·49

The following conclusions may be drawn:—

(1) Hampshire × native lambs cannot be finished into Highland lambs from ley or rape as grown on the Eldoret farm without supplementary feeding.

(2) Although the clover-fed group made better liveweight gains, the rape-fed group were more acceptable to the butcher as their gains seemed to be more meat and less frame and consequently their killing-out percentages were considerably better. However, none of the carcasses was properly finished and even the one Highland lamb was lacking in fat and finish.

(3) If the grazing cannot be improved the Kenya Meat Commission and the butcher advised that the lambs be kept on for Highland mutton after another 7-9 months.

Calves.—A trial was begun to investigate the economic, practical and nutritional factors in weaning Red Poll calves at three weeks of age on to a specially prepared meal. The calves are left with their dam for two days, then fed whole milk until 21 days old, consuming a total of 13 gallons. The meal is introduced on the tenth day and is made available to a maximum of 4 lb./calf/day until 87 days of age. As a control another group of calves is reared as in normal practice on whole milk to 11 weeks (62 gallons), hay and concentrates. There are no apparent visual differences between the two groups and liveweight gains are the same. There appears to be a net saving per calf by the early weaning method of:—

Sh. 16 when the whole milk is costed at Sh. 1/25 gallon.

Sh. 28 when the whole milk is costed at Sh. 2/18 gallon.

This does not include the very considerable saving in labour attributable to the early weaning system.

Ol Joro Orok

Drainage Trials.—A trial on the drainage of vlei land compared moles alone, tiles alone, moles plus tiles and control (no drainage). The test crop was R.L. 1734 oats.

Treatment	Yield in bags/acre	Comments
Moles alone	12·0	No surface water at any time.
Tiles alone	8·03	Surface water for approximately 6 weeks.
Moles + tiles	9·5	No surface water.
Control	4·57	Water-logged for 3 months of growing period.

The crop suffered a severe check due to heavy rainfall during July-September. The field average was 8.3 bags/acre, some of the area having better natural drainage. It would have been expected that in such a wet year moles plus tiles should have given the best result. However, at the end of the heavy rains, there was an eight-weeks' drought, and over-drainage during this period could have lowered the yields from the moles and tiles treatment.

Fertilizers.—A randomized block experiment to compare the effect of nitrogenous and phosphatic fertilizers on maize in the Mount Kenya region used the following treatments:—

(*a*) Control (no fertilizers).

(*b*) 100 lb. triple superphosphate at planting.

(*c*) 100 lb. triple superphosphate at planting plus 157 lb. sulphate of ammonia at the knee-high stage, and

(*d*) 200 lb. per acre of ammonium phosphate at planting.

There were four replications. Treatments (*b*) and (*d*) had the same P_2O_5 level per acre and similarly (*c*) and (*d*) the same nitrogen level per acre.

Phosphate alone at the 100 lb. level significantly increased the yield of maize by three bags/acre, but when followed by the sulphate of ammonia at the knee-high stage this did not significantly increase the yield over control. Nitrogen applied in the seedbed had no significant effect on yield above the level obtained from phosphate alone.

An experiment on the residual effects of basic slag on vlei soil and Ol Joro Orok red loam applied in 1957 gave the following results:—

Soil Type	Date Sown	Date Harvested	Yield in Bags per Acre	
			Slag	No Slag
Vlei	17–6–58	23–12–58	0·6	0·35
Red Loam	24–8–58	23–1–59	10·79	5·5

On the vlei the crop was R64 wheat and the yield average was 1.0 bags/acre. On the loam, Heimdal barley averaged 11.5 bags/acre. There were no differences in time to maturation. The vlei land was waterlogged for six to eight weeks even although it was tile-drained.

Potato Observation Trials.—Seven varieties of potatoes have been compared with the following results:—

Varieties	Yields in Tons/Acre	Blight Resistance
P. Brockema	6·8	Fairly high.
C.52	9·9	Fairly high.
Pimpernel	3·7	Fair.
Tedria	4·4	Fair.
Kerr's Pink	0·6	None.
Dutch Robijyn	5·4	High.
E.52	9·0	High.

Yields have been disappointingly low, especially of Dutch Robijyn and E.52. Blight attack affected yields of all varieties, especially Kerr's Pink which appears to have no resistance whatsoever.

Livestock

Pigs.—A preliminary observation trial with one litter on the Lehmann system of pig-feeding gave results as follows:—

	Lehmann System	Normal Feeding	Difference
Total lb. concentrates fed	2,742	3,801	—
Average weeks to 200 lb. l/wt.	21	20	1
Feed cost at 50 cents/lb.	548·40	760·20	211·80
Cost per pig	91·40	126·70	35·30
Average conversion ratio	4·0	4·60	0·20

These results justify a continuation of the trial under statistical control.

Sheep.—The first fat lambs have been sent for slaughter. Liveweights and fleeceweights of Corriedale and Hampshire Down × Corriedale have been recorded. Results to date:—

Breed	Av. Days to Slaughter	Av. L/Wt. Gain/Day	Return per Head		
			Meat	Wool	Total
		lb.	*Sh.*	*Sh.*	*Sh.*
14 high grade Corriedale	223 (*1)	0·35	54/50	11/37	65/87
14 Hampshire Down × Corriedale	203 (*2)	0·36	86/13	2/50	88/63

*1 All mutton at 1/56 per lb.

*2 Two as mutton; eleven as Highland lamb (27–40) at 2/50 per lb.; one Highland lamb (41–45 at 2/25 per lb.

Lambs were shorn and Corriedale fleeces averaged 6½ lb. at Sh. 1/75 per lb. Hampshire Down × Corriedale weighed 2½ lb. on average at Sh. 1 per lb. Corriedales are also being kept on to one full wool clip and sold as mutton at 12-14 months of age.

Kitale

Maize Trials

Comparison of Row Spacings in Maize

Yield in bags/acre

	3′ 6″	6′ 6″	7′ × 2′	Level of Sig.
1955	16·8	14·1	—	1%
1956	21·4	19·1	—	1%
1957	19·1	18·4	—	Not Sig.
1957	23·7	—	20·3	Not Sig.
1957	23·1	—	21·6	Not Sig.
1958	20·0	17·4	17·7	Not Sig.

Over four years the standard 3 ft. 6 in. row spacing has outyielded the 6 ft. 6 in. single-row spacing by 2.1 bags/acre. Over three years the standard 3 ft. 6 in. row spacing has outyielded the 7 ft. × 2 ft. double-row spacing by 2.4 bags/acre. There is obviously very little difference (0.3 bags/acre) between the 6 ft. 6 in. single-row and 7 ft. × 2 ft. double-row spacing.

Weed Spray on Maize.—In the summary of experiments, 1957, one of the conclusions drawn after three years' trials was as follows:—

> "An attempt to compare spray only with cultivation only as a means of weed control was defeated by a heavy volunteer growth of grass in the spray plots, despite the fact that the field was clean at planting. The difference in yield was five bags per acre in favour of the cultivated plots.
>
> "This trial will be continued on a field newly broken from ley."

The treatments in the trial carried out on land newly broken from ley at Kitale Station in 1958, using 7 ft. × 2 ft. spacing, were:—

(*a*) One cultivation 17 days after planting, one spray application (Agroxone) 24 days later.

(*b*) One spray application 17 days after planting (maize 4 in.–5 in. high) and another spray application 24 days later in the wide rows only.

(*c*) One cultivation 17 days after planting and another cultivation 24 days later in the wide rows only.

Results in bags/acre:—

(*a*) 26.32
(*b*) 26.88 } Differences are not statistically significant.
(*c*) 25.15

The plots which received both cultivation and spray treatments were cleaner in the narrow 2-ft. rows. Annual grasses occurred to a greater extent in the spray only treatment, although the grass did not affect yields. The field, being newly broken, did not suffer from a high weed infestation, otherwise treatment differences might well have been greater.

Fertilizers on Maize

Effect of Time of Application of Sulphate of Ammonia

Summary of previous results:—

Treatment	Yield in Bags/Acre		
	1955	1956	1957
1. No S/Ammonia	14·4	19·0	16·3
2. 2 cwt. S/Amm. at planting	15·0	20·0	19·5
3. 2 cwt. S/Amm. on maize 2′ 6″ high	16·6	22·0	21·5
4. 1 cwt. S/Amm. at planting plus 1 cwt. on maize 2′ 6″ high	15·9	20·0	17·9

Each of the above treatments received a uniform application of superphosphates. All yield increases due to top dressing of maize at 2 ft. 6 in. high were significantly greater than control (no S/Amm.) at the 1 per cent level. Over the three years the average increase in yield from top dressing was 3.46 bags/acre.

Table of Results of 1958 Trial

Treatment	Yield in Bags/Acre
C. 200 lb. S/Amm. on maize 2′ 6″ high	26·5
D. 50 lb. S/Amm. at planting plus 100 lb. S/Amm. on maize at 2′ 6″ high plus 50 lb. S/Amm. on maize at tasseling	26·2
A. 50 lb. S/Amm. at planting plus 150 lb. S/Amm. on maize 2′ 6″ high	26·0
E. 50 lb. S/Amm. at planting	24·5
B. 50 lb. S/Amm. at planting plus 150 lb. S/Amm. on maize at tasseling	23·5
F. No S/Ammonia	23·1

While this trial does not significantly confirm previous results, it does show that the nitrogen is best applied at the knee-high stage. Treatments C, D and A are significantly better than control at the 10 per cent level.

Nitrogen and Phosphate on Maize.—A field on the Kitale Station broken from ley and then sown to oats for grazing was used to compare three rates of sulphate of ammonia (0 lb., 100 lb. and 200 lb. per acre), three rates of superphosphate (50 lb., 75 lb. and 100 lb. per acre), and three different plant populations.

Table of Results in Bags/Acre

Treatment	Yield
0 lb. Sulphate of ammonia/acre	24·9
100 lb. Sulphate of ammonia/acre	28·1
200 lb. Sulphate of ammonia/acre	27·5
50 lb. Superphosphate/acre	26·5
75 lb. Superphosphate/acre	26·8
100 lb. Super phosphate/acre	27·0

Both 100 lb. and 200 lb. S/Amm. produced a response significant at the 5 per cent level. There are no significant differences between the three rates of supers. Superphosphate was applied at planting. 50 lb. S/Amm. was applied at planting and the remainder when maize was 2 ft. 6 in. high.

From one year's trial only it appears that 50 lb. superphosphate per acre is as effective as 100 lb./acre. Also that 100 lb. S/Amm. is as effective as 200 lb. S/Amm. per acre.

Another nitrogen and phosphate on maize trial was laid down on Mr. J. R. Brooke's farm, Cherangani. A field broken from veld then planted to sunflower for seed was used to compare three rates of S/Amm. (0 lb., 100 lb. and 200 lb. per acre), three rates of superphosphate (50 lb., 75 lb. and 100 lb. per acre), and three plant populations (results of which appeared earlier).

Table of Results in Bags/Acre

Treatment	Yield
0 lb. S/Amm. per acre	12·2
100 lb. S/Amm. per acre	14·8
200 lb. S/Amm. per acre	16·2
50 lb. Superphosphate	14·7
75 lb. Superphosphate	14·8
100 lb. Superphosphate	13·7

Both 100 and 200 lb. S/Amm. per acre are superior to control at the 1 per cent level of significance. 200 lb. is superior to 100 lb. S/Amm. per acre at the 5 per cent level. There is no statistical significance between the three rates of superphosphate.

Thus on land as new as the one used for experimenting, 200 lb. of S/Amm. per acre is a worthwhile application, producing a four bags/acre increase.

Again it appears from one year's trial only that 50 lb. superphosphate is as effective as 100 lb. per acre.

Pig Dung on Maize.—Pure pig dung about two years' old was applied in the row (I.R.) by ridging and placing dung in the furrow, and by broadcasting and covering (B.C.). The rates were five tons and ten tons per acre and the four combinations were compared with 80 lb. superphosphate per acre only (control).

Table of Results in Bags/Acre

Treatment	Yield
5 tons I.R.	27·8
10 tons B.C.	26·8
5 tons B.C.	26·8
10 tons I.R.	25·8
Control	19·1

There is no significance between yields from any pig-dung treatment, but yields from all pig-dung treatments are significantly better than the control yield.

Thus five tons of pure pig dung broadcast or applied in the row (which ever is the easier) is adequate to produce as high a yield as produced by ten tons. Residual effects of pig dung will be determined from a trial laid down on the same plots without further applications in 1959.

Banding versus In-row Placement of Artificial Fertilizer on Maize

Banding = Placing 100 lb. superphosphate and 50 lb. S/Amm./acre about 2 in. on either side of the maize seed.

In-row = Placing the same amount of each of the above fertilizers in the row in direct contact with the maize seed.

Both treatments received a top dressing of 100 lb. S/Amm. per acre when maize was 2 ft. 6 in. high.

Table of Results in Bags/Acre

Treatment	Yield
Banding..	24·8
In-Row	24·2

Differences are not significant

Neither superphosphate nor S/Amm. appears to have any adverse effect on maize yield when the fertilizers are in direct contact with the seed.

Alternative Crops to Maize.—Eleven different crops have been under observation as possible alternatives to maize for the Trans Nzoia. These are castor, soybeans, simsim, linseed, lentils, green grams, white grams, Michigan pea beans, sweetcorn, groundnuts, Niger and Sesamum Angolense. Final results from these trials are not yet available, but the crops showing most promise are castor and soybeans.

Animal Husbandry.—An abrupt weaning trial on Jersey calves, similar to the Eldoret trial, has completed its first phase. Unlike Eldoret, consumption of the early weaning meal has been excessive and the experiment will continue in 1959 in an effort to control meal intake and hence rearing costs.

Pigs.—An experiment was laid down to compare three protein supplements: skim milk, cottonseed cake and blood meal all fed with corn and cob meal. The most successful supplement was the skim milk, results of which have appeared in the *East African Farmer and Planter,* December, 1958.

On the cottonseed treatment three out of 14 pigs died due to gossypol poisoning, too high a level of cottonseed having been fed. The bloodmeal group developed deficiencies which were corrected through feeding small quantities of nicotinic acid. These trials, in conjunction with E.A.A.F.R.O., continue.

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (RESEARCH), NORTHERN DIVISION NYANZA PROVINCE, 1958

Weather

The monthly rainfall totals for the stations are given in the Appendix.

Rainfall has been very patchy, Kakamega receiving 10 in. less than normal, distribution also being poor. Busia also received much less than normal, but distribution was good and fair crops resulted apart from groundnuts. At Kakamega, Kisumu and Miwani the short rains failed.

Reports on Experiments

Exploratory Fertilizer Trials

Seventeen trials were laid down on the major soil types during the year. The results have been reported on by the Senior Soil Chemist.

Fertilizer Rates Trials

The NPK 3^3 factorial on a red basalt loam at Kakamega continued in its second year under maize, the yield figures are given in Table I in lbs. per acre.

Table I—Yields of Maize in lbs./acre

Sulphate of Ammonia		Double Superphosphate		Muriate of Potash	
Rate	Yield	Rate	Yield	Rate	Yield
cwt./acre	*acre*	*cwt./acre*	*acre*	*cwt./acre*	*acre*
1·44	2,143	1·44	2,350	1	2,109
0·96	2,167	0·96	2,153	0·5	2,142
Nil	2,097	Nil	1,904	Nil	2,157
Mean ..	2,136		2,136		2,136

Least Significant Difference: P = 0·05 161 lbs./acre.
P = 0·01 219 lbs./acre.

Double superphosphate gave significant responses and although the NP interaction failed to achieve significance there was evidence of beneficial use of nitrogen in the presence of the higher rate of phosphate. No other treatment or interactions were significant.

Observations on a Grass Legume Grid, Kakamega

This consisted of a ley underplanted to 1957 maize in which strips of Slender Guinea Grass, Nzoia Rhodes, and Nandi Setaria were crossed by strips of Hunter River Lucerne, Lousiana White Clover, and Kenya Wild White Clover.

Early in the long rains, the Lucerne dominated the Slender Guinea. Harder grazing restored the balance, but after the failure of the short rains little Lucerne remains. The Rhodes Grass has already invaded the Slender Guinea by seed. Nandi Setaria remains bunchy and wiry and will not fill the ground on its own. Many weeds have come in. The two Clovers survive. Nzoia Rhodes gives the best cover, is more palatable and appears to provide more bulk than the other grasses. It appears to be too strong a competitor for Kenya Wild White Clover which remains suppressed. The best mixture so far is Nzoia Rhodes and Lousiana White Clover.

Testing of Eight Strains of Rhodes Grass at Kakamega

Nzoia still leads easily at Kakamega in palatability and productivity. Chepararia and Endebess are liked and grow well. Rongai is coarse and is always grazed last and never fully. Mpwapwa is quite liked but less so than Chepararia and Endebess. Alego is palatable but is too thin on the ground to be worthwhile. Mbarara and Kabarnet are intermediate.

Establishment of a Ley at Kakamega underplanted to Maize and Beans with and without Phosphate and Manure Treatment

It was demonstrated that at Kakamega a stargrass ley could be successfully underplanted to beans but that the application of manure was necessary in these conditions to produce an economic beanscrop. The ley following the beans produced an earlier bite than that following the maize, but the latter gave an economic crop even without F.Y.M. It should be noted however that the ground was naturally fertile, the rest of the field producing a 16 bags per acre maize crop without fertilizer or manure.

For yields of maize and beans *see* Tables II and III.

Table II—Mean Yield of Maize in lbs. per acre

	M_0	M_1	Mean
P_0	1,533	2,079	1,806
P_1	1,932	2,200	2,066
Mean ..	1,732	2,140	1,936

L.S.D. $p = 0{\cdot}05$ 166
$p = 0{\cdot}01$ 251

Table III—Mean Yield of Beans in lbs. per acre

	M_0	M_1	Mean
P_0	98·34	436·96	267·65
P_1	185·06	441·54	313·30
Mean ..	141·70	439·25	290·48

L.S.D. $p = 0{\cdot}05$ 21·707
$p = 0{\cdot}01$ 32·890

Both in the cases of maize and of beans, the response to manure was highly significant both in the presence and absence of phosphate.

The response to phosphate in the absence of manure was highly significant, but was not significant in the presence of manure.

Maize Variety Trial

The trial at Kakamega, which included local varieties, hybrids, and synthetics, was carried out in co-operation with Mr. Harrison of E.A.A.F.R.O. who recorded and is reporting on this trial.

Maize Spacing Trials

Four trials comparing the spacings 3 ft. × 6 in., 2 ft. × 1 ft., 3 ft. × 9 in., 3 ft. × 1 ft., 4 ft. × 1 ft., 3 ft. × 1½ ft. each with one plant per hole and 4 ft. × 1 ft. with two plants per hole were conducted at Kakamega, Siriba, Busia and Kimilili. There were four randomized blocks at each site. The results are given in Table IV.

Table IV—Yields of Maize Grain in Tons per Acre

Spacing Treatments		Combined Yields of the Trails at Busia, Kimilili and Kakamega	Yeilds at Siriba
3′ × 6″		1·089	1·175
2′ × 1′		1·172	
4′ × 1′ (2 plants/hole)		1·107	1·234
3′ × 9″		1·170	1·251
3′ × 1′		1·193	1·564
4′ × 1′ (1 plant/hole)		1·122	
3′ × 1½′		1·151	1·369
L.D.S.'s between means	P = 0·05	0·159	0·798
	P = 0·01	0·211	1·161

The plant populations varied between 9,680 and 21,780 per acre but no significant differences in yields were obtained.

Observation Plots of Blight Resistant Potatoes

The three blight resistant varieties E.52, K.52, and C.53, were tested in a randomized block design at Kakamega with Dutch Robijyn as control. 12 tons of F.Y.M. were given but no artificials.

Mean yields were as follows:—

Variety	*Yield (tons/acre)*
E.52	10.97
K.52	9.01
C.53	8.47
Dutch Robijyn	7.55

C.53 did not fill the ground. A closer spacing might well have reversed the order of these varieties.

Sugar Cane Variety Trial, 16 Varieties 2nd Ratoon

This trial was brought to a successful conclusion on the red sandy loam of Upper Miwani. The first seven varieties appear in Table V firstly in the order of yield of cane and secondly in the order of yield of sucrose.

TABLE V

Yield of Cane			Yield of Sucrose		
Order	Variety	Tons/Acre	Order	Variety	Tons/Acre
1	Co 453 ..	56·49	1	B. 37193 ..	4·385
2	B. 37193 ..	47·15	2	NCo 330 ..	4·378
3	Co 411 ..	46·88	3	Co 421 ..	4·353
4	Co 421 ..	46·36	4	Co 411 ..	4·291
5	Co 290 ..	45·87	5	Co 453 ..	3·908
6	NCo 330 ..	43·56	6	Co 290 ..	3·888
7	B. 41227 ..	43·35	7	B. 41227 ..	3·729
L.S.D. at p = 0·05 =		8·91	LSD at p = 0·05 =		1·058
0·01 =		11·90	0·01 =		1·413
0·001 =		15·58	0·001 =		1·851

In yield of cane Co.453 yielded significantly better than all varieties. When converted to sucrose however, it fell to fifth place and, although not significantly worse than the first four varieties, must have its high yield of low quality cane regarded as a drawback, as it means higher cutting and transport costs for the same return. Its spreading habit is also a disadvantage at harvest.

The rise of NCo.330 from sixth place in cane to second in sucrose is interesting; but the differences in cane between this and the varieties above it, apart from Co.453, were not significant in any case and NCo.330's spreading habit is also a disadvantage.

B.37193 undoubtedly comes well out of this trial and, with its erect habit, must be regarded as distinctly promising.

SUGAR CANE VARIETY TRIAL, 25 VARIETIES 1ST RATOON

This trial at Miwani was harvested in December, 1957.

The first 12 varieties appear in Table VI firstly in the order of yield of cane cane and secondly in the order of yield of sucrose.

TABLE VI

Yield of Cane			Yield of Sucrose		
Order	Variety	Tons/Acre	Order	Variety	Tons/Acre
1	Co 331 ..	59·77	1	NCo 339 ..	5·04
2	NCo 349 ..	50·00	2	Co 331 ..	4·97
3	NCo 339 ..	49·11	3	Co 281 ..	4·57
4	Co 301 ..	43·70	4	NCo 349 ..	4·30
5	NCo 310 ..	42·96	5	NCo 310 ..	4·01
6	Co 411 ..	42·83	6	NCo 330 ..	3·95
7	Co 434 ..	42·57	7	Co 434 ..	3·84
8	Co 281 ..	42·31	8	NCo 291 ..	3·73
9	Co 312 ..	39·96	9	Co 301 ..	3·65
10	NCo 330 ..	38·87	10	NCo 334 ..	3·53
11	NCo 334 ..	38·38	11	Co 411 ..	3·51
12	NCo 291 ..	38·37	12	Co 312 ..	3·50
L.S.D. at p = 0·05		15·01			
p = 0·01		20·34			

Co.331 maintained its good record by coming top, but did not outyield significantly the next two varieties. A point of interest is the spectacular rise of the old commercial variety Co.281 from eighth place in cane yield to third place in sucrose yield.

Sugar Cane Variety Trial, 25 Varieties under Irrigation 1st Ratoon

This trial at Miwani was harvested in September, 1958.

The first 12 varieties appear in Table VII firstly in the order of yield of cane and secondly in the order of yield of sucrose.

Table VII

Yield of Cane			Yield of Sucrose		
Order	Variety	Tons/Acre	Order	Variety	Tons/Acre
1	B. 41227 ..	87·74	1	B. 41227 ..	8·57
2	B. 37193 ..	76·83	2	B. 41211 ..	7·86
3	Co 331 ..	75·78	3	NCo 310 ..	7·73
4	NCo 310 ..	75·75	4	Co 419 ..	6·94
5	Co 419 ..	74·99	5	Co 421 ..	6·90
6	Co 408 ..	74·16	6	B. 37193 ..	6·71
7	B. 41211 ..	73·78	7	PoJ 2961 ..	6·70
8	Co 421 ..	71·69	8	PR 809 ..	6·50
9	PoJ 2961 ..	71·03	9	Co 408 ..	6·15
10	PoJ 2725 ..	68·73	10	M 134/32 ..	6·02
11	PoJ 2875 ..	65·81	11	PoJ 2875 ..	5·74
12	Co 453 ..	65·75	12	NCo 79 ..	5·74
	L.S.D. at p = 0·05	12·113		LSD at p = 0·05	1·141
	p = 0·01	16·415		0·01	1·547

B.41227 outyielded significantly or highly significantly all varieties listed below NCo.310 in both analyses, but a point of interest is that Co.331, third in cane yield, plummets to twenty-first place in sucrose, whilst B.37193, second in cane yield, drops to sixth in sucrose. NCo.79 was mixed and the figure given is a corrected one. NCo.310 and Co.419 were inclined to lodge.

Poor Land Improvement Sugar Cane Trial

In this trial at Miwani, four main treatments: control, ripping, gypsum application, and gypsum plus ripping, were split for six sub-treatments: control, green manure, filter press mud application, trash ploughed in, trash as mulch, and a compound NPK fertilizer. The trial was replicated three times.

The site was subject to impeded drainage. The results are given in Tables VIII and IX.

TABLE VIII—MEAN YIELDS OF CANE IN TONS/ACRE

Main Plot Treatments

Split Plot Treatments	Control	Ripping	Gypsum	Ripping and Gypsum	Mean
Control	32·951	43·259	45·429	48·031	42·417
Green Manure	42·971	48·022	52·361	56·169	49·790
Filter Press Mud ..	42·467	51·407	49·561	54·396	49·458
Trash	28·467	33·221	43·988	51·830	39·376
Mulch	32·582	42·863	41·900	53·198	42·635
Fertilizer	40·054	53·108	48·292	45·069	46·630
Means.. ..	36·522	45·313	46·922	51·449	45·051

L.S.D. p = 0·05 6·9503 } Main plot treatment means.
0·01 10·5290 }

0·05 3·8397 }
0·01 4·6050 } Split plot treatment means.
0·001 6·7477 }

0·05 7·6795 }
0·01 9·2100 } Individual treatment means.
0·001 13·4954 }

TABLE IX—MEAN YIELDS IN TONS/ACRE

Main Plot Combined Treatment Effects

Split Plot Treatments	No Gypsum	Gypsum	Mean
Control	38·105	46·730	42·417
Green Manure ..	45·316	54·265	49·790
Filter Press Mud ..	46·937	51·979	49·458
Trash	30·844	47·909	39·376
Mulch	37·722	47·549	42·635
Fertilizer	46·581	46·680	46·630
Mean ..	40·917	49·185	45·051

	No Ripping	Ripping	Mean
Control	39·190	45·645	42·417
Green Manure ..	47·486	52·096	49·791
Filter Press Mud ..	46·014	52·901	49·457
Trash	36·228	42·525	39·377
Mulch	37·241	48·031	42·636
Fertilizer	44·173	49·089	46·631
Mean ..	41·722	48·381	45·051
L.S.D. p =	0·05	5·4333	
	0·01	6·5136	
	0·001	9·5431	

Both gypsum and ripping were highly beneficial, but neither enhanced the effectiveness of the other.

There was no interaction with ripping of any of the sub-treatments; but, except in the case of filter press mud, compounded fertilizer, and green manure gypsum was necessary for any beneficial action from the sub-treatments. In fact without gypsum the effect of trashing was highly significantly damaging. Mulch had no effect at all.

Ratoon Cane Fertilizer Trial with Nitrogen on Sandy Soil

There were four levels of nitrogen in this Miwani trial, with two methods of application (on top of trash M_1 and to soil under trash M_2) and two times of application T_1 and T_2.

All N treatments yielded significantly better than the control, but there were no significant differences between N treatments.

Summary of Mean Yields in Tons/Acre

N_0	N_1	N_2	N_3
44·99	53·29	51·68	53·41
L.S.D. p =	0·05	5·688	
	0·01	7·932	

Applying N to soil under trash, immediately after cutting, significantly depressed the yield compared with applying N on top of trash, immediately after cutting; but the reverse effect was encountered when the application was made during the short rains. This latter increase however was not significant. *See* Table X.

Table X—Mean Yields of Cane in Tons per Acre

	M_1	M_2	Mean
T_1	53·32	45·86	49·590
T_2	50·29	53·91	52·100
Mean ..	51·805	49·885	50·845
L.S.D. p =	0·05	5·688	Body of table means.
	0·01	7·932	
	0·05	4·021	Marginal means.
	0·01	5·607	

Nitrogen Fertilizer, Molasses and Filter Press Mud Trial on Sugar Cane

A 3 × 2 × 2 fertilizer trial comparing the effects of sulphate of ammonia, molasses and filter press mud on the yields of sugar cane at Miwani was completed in 1958. There were no responses to filter press mud or molasses in either of the two ratoon crops. Sulphate of ammonia gave only slight increases in yield in the first ratoon crop but gave very large increases in the second. The results are given in Table XI.

TABLE XI—YIELDS OF SUGAR CANE IN TONS/ACRE

	Sulphate of Ammonia			L.S.D.	
	Nil	3 cwt./acre	6 cwt./acre	p = 0·05	p = 0·01
1st Ratoon ..	27·75	28·90	29·90	4·11	5·50
2nd Ratoon ..	23·12	33·20	40·19	2·31	3·10

When applied to the second ratoon crop sulphate of ammonia at 3 cwts./acre increased the yield by 10.08 tons/acre; at 6 cwts./acre the yield was increased by 17.07 tons/acre.

Deep Planting and Ridging of Sugar Cane at Kakamega

Planting in trenches 1 ft. deep as compared with planting on the flat and combined with two varieties and three times of earthing up.

This experiment was planted in October, after which all rain disappeared. Planting on the flat died almost universally, but the deep planting has given an almost 100 per cent stand.

The indications are that in dry conditions deep planting is more than justified.

Couch Control by Herbicides

Various combinations of Pentachlorophenol, Aminotriazole and Dowpon were used in an observational trial. Couch was eye scored at intervals between August, 1958 (pre-application) and February, 1959 (conclusion). Prior to application the trial was estimated to have an even stand of 70 per cent couch throughout.

The treatment 10 lb. of Dowpon in one application followed by 5 lb. on re-emergency was shown to be the most effective, but also the most expensive.

Pentachlorophenol in the form of Shell "Q" was ineffective, as its creosote emulsifying agent scorches off the grass too quickly to allow penetration of the poison, with the result that regeneration is speedy and complete.

The most economical treatment appeared to be 5 lb. of Aminotriazole plus 2½ lb. Dowpon which gave a reduction of couch infestation from 70 per cent to 5 per cent, a level easily controlled by hand.

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APPENDIX

Rainfall at Experimental Stations, 1958 (inches)

	Bukura	Busia	Kakamega	Kibos	Kisumu	Miwani
Jan. ..	2·81	0·81	2·16	0·50	0·52	0·71
Feb. ..	5·62	4·57	4·72	4·50	2·86	6·33
March ..	8·64	2·65	4·83	5·86	4·77	8·92
April ..	5·69	6·25	4·63	7·43	4·08	5·19
May ..	15·77	7·83	13·14	5·68	4·30	6·02
June ..	9·12	5·31	6·62	4·56	5·13	3·75
July ..	3·63	0·95	6·03	4·73	3·01	6·15
Aug. ..	7·13	3·32	10·56	3·65	3·86	3·03
Sept. ..	6·29	4·64	2·46	2·96	2·36	1·49
Oct. ..	5·67	3·64	3·76	2·65	4·42	6·05
Nov. ..	3·08	2·38	0·88	0·79	0·41	1·39
Dec. ..	4·64	3·57	6·04	1·56	1·50	4·40
Total ..	78·09	45·92	65·83	44·87	37·22	53·43

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General

RAINFALL, 1958—9

	Sotik	Bomet	Kabosson	Senetwet	Kisii	Homa Bay
Jan. ..	1·32	1·38	1·99	—	2·68	1·29
Feb. ..	4·62	3·53	4·96	—	6·04	5·39
March ..	4·28	6·56	4·61	—	7·99	2·26
April ..	5·81	3·71	7·00	—	11·00	12·20
May ..	11·76	8·26	5·53	—	9·23	6·95
June ..	2·50	0·70	2·34	—	7·40	4·67
July ..	3·53	2·73	1·81	—	4·47	1·99
Aug. ..	7·55	4·05	1·85	3·81	6·67	2·68
Sept. ..	2·77	2·25	1·62	3·25	6·91	3·28
Oct. ..	4·46	3·21	3·20	4·14	9·40	5·04
Nov. ..	1·33	2·27	0·47	0·60	2·61	2·49
Dec. ..	2·66	6·13	1·30	6·49	5·02	4·47
TOTAL ..	52·59	44·78	36·68	18·29	79·72	52·71
3 years average ..	53·27	48·12	—	—	79·58	44·67

The weather followed the normal trend in most places except at Bomet which was exceptionally dry compared with the previous year. Rain held up cultivations and then largely disappeared with the result that the experimental results from Bomet are poor. The long rains at Sotik were slow to start and were quickly over. The year was marked by very short and wet periods followed by long dry periods.

This year with the change in policy at Sotik Station towards an experimental programme with marked "grass bias" much of the work was concerned with the establishment of grass leys and the improvement of natural grazing. However with the seemingly innumerable and basic questions on arable crops which were unanswered in this area a larger programme of arable work was carried out than was anticipated.

The following report embraces some of the more important trials carried out in the district this year.

FERTILIZER TRIAL ON VLEI LAND

A 2^5 factorial experiment was put down on vlei land at Messrs. Buchanan's Kenya Estates Limited.

The treatments were as follows:—

(1) Zinc sulphate .. .. .. at 0 and 10 lb. per acre.
(2) Lime .. .. at 0 and 2½ tons per acre.
(3) Gypsum .. .. at 0 and 2 cwt. per acre.
(4) Kieserite .. .. .. at 0 and 1½ cwt. per acre.
Sodium molybdate .. .. at 0 and 6 oz. per acre.
Borax .. .. at 0 and 20 lb. per acre.
(5) Muriate of potash .. .. at 0 and 1½ cwt. per acre.
Manganese sulphate .. .. at 0 and 25 lb. per acre.
Copper sulphate .. .. at 0 and 20 lb. per acre.

Two replicates were used, one of *Trifolium ruepellianum* and the other Research Mid-season barley.

In the clover replicate lime decreased the yield significantly (5 per cent) but in the barley replicate responses were obtained to lime which increased the yield significantly (5 per cent) and to treatments 5 and 4 which were significant at the 1 per cent and 0.1 per cent respectively.

However yield of the control plot of barley was only 0.86 bags per acre and these significant responses must be used with caution. The overiding factor was that the land was drained by a contour ditch on a 1 per cent grade and so was so wet during the growing season that the root growth was impossible. What looked like being an excellent crop just after "piping" was an exceptionally poor one. The clover grew very well and produced an average over all plots of 14.86 tons of fresh matter per acre.

Maize Manurial Trial, Sotik

The uniformity of this trial was completed in 1957-1958. This year the experiment proper was laid down. The treatments were FYM at 0, 7½ and 15 tons per acre, and Sulphate of Ammonia and Superphosphate each at 0, 0.96 and 1.44 cwt./acre. The results are given in Table I.

Table I—Yields of Maize in Bags/Acre

Treatment		Yield
F.Y.M.	0 tons	18·35
	7½ tons	22·84
	15 tons	24·25
Sulphate of Ammonia ..	0 cwt.	21·71
	0·96 cwt.	22·62
	1·44 cwt.	21·11
Superphosphate	0 cwt.	16·40
	0·96 cwt.	23·69
	1·44 cwt.	25·35

S.E. = 1.76 bags/acre.

Responses to both levels of phosphate were significant, the higher rate was significant at the 1 per cent level and the lower at the 5 per cent level.

The higher rate of manure (15 tons/acre) was better than the control, significant at the 5 per cent level.

Manurial Trial on *Setaria splendida*

This was a 2^3 factorial design with F.Y.M. at 0 and 7 tons per acre, Superphosphate at 0, and 1 cwt. per acre and Sulphate of Ammonia at 0 and 1 cwt. per acre. The latter two were reapplied at the beginning of the short rains.

Table II—Tons/Acre Fresh Matter

Nil	N	P	NP	M	NM	PM	NPM	S.E. diff. 2 means
23·93	19·69	31·28	27·58	25·63	23·88	33·55	33·92	2·89

The Superphosphate gave a response significant at the 0.1 per cent level and the F.Y.M. at the 5 per cent level.

An *observation* trial at Kisii on this same grass has shown yields far in excess of those at Sotik.

Observation Plots on Seeding Clovers into Natural Grassland

Lines 2 feet apart were cut in a Star/Kikuyu paddock at three different widths; approximately 2 inches, 4 inches and 9 inches. Phosphate was applied in the drills at the rate of cwt. Superphosphate per acre and inoculated seed of the following clovers were sown:—

Trifolium semipilosum, Kenya White Clover;

Trifolium ruepellianum, Ruepells Clover;

Trifolium repens., Louisiana Clover;

Trifolium repens., Bamenda Clover;

Trifolium subterraneum of the Dwalganup strain; and

Trifolium subterraneum of the Yarloop strain.

With the exception of the Kenya White and Ruepells Clover all were killed out by the competition of the grass filling in the planting lines and even these survived only in the wide drills. It appears that if this method of pasture improvement is to be used then wide drills must be used and it would be better to use indigenous clovers.

Co-operative Observation Trials on the Improvement of Natural Grassland

It was considered that cultivation combined with fertilizers should have the effect of flushing the local Star/Kikuyu/couch pastures which in general produce little bulk during the year when compared with ley pasture. Accordingly four cultivation treatments were used namely control, heavy discing, tillering to a depth of 3 inches, and subsoiling to a depth of 10 inches. Each plot was split for fertilizers as follows: control, Sulphate of Ammonia at $1\frac{1}{2}$ cwt./acre, Superphosphate at 1 cwt./acre; Sulphate of Ammonia and Superphosphate together at these rates.

The results were disappointing. The best plots in general were those which had been tillered and dressed with both Sulphate of Ammonia and Superphosphate. Nowhere could the response be called economic, and nowhere was it possible to get sample cuts owing to, firstly, the limited responses, and secondly, to the rough state of the ground after cultivation.

Ley Species Trial, Sotik

This trial was put down to evaluate the production of Rhodes Grass (Nzoia strain) (*Chloris gayana*), Nandi Setaria (*Setaria sphacelata*) and Star grass (*Cynodon dactylon*) with Louisiana and Kenya White Clovers (*Trifolium repens* and *Trifolium semipilosum*). The plots were split for phosphate versus nil at 150 lbs. per acre.

The trial was almost washed out of the ground by heavy rain, this was followed by very dry weather and as a result it was three months before it was ready for sampling.

The following is the table of results up to 31st December, 1958 and includes three cuts.

TABLE III—TONS FRESH MATTER PER ACRE

	RHODES		SETARIA		STAR		S.E. diff. 2 means 0·07
	O	P	O	P	O	P	
Kenya White Clover ..	7·56	13·41	5·94	16·05	6·39	10·20	9·93
Louisiana Clover	4·71	14·10	5·85	13·44	3·93	8·31	8·40
S.E. diff. 2 means 1·12 ..	6·12	13·74	5·91	14·76	5·16	9·27	
S.E. diff. 2 means 0·86 ..	9·93		10·35		7·23		

S.E. of the difference between 2 treatments means = 1.72 tons/acre.

Of the grasses Setaria out-yielded Star Grass, significant at the 0.1 per cent level and Rhodes Grass also out-yielded Star Grass, significant at the 1 per cent level.

The mixtures containing *Trifolium semipilosum* out-yielded those of *Trifolium repens* significant at the 5 per cent level.

The yields of the phosphate plots exceeded those of the non-phosphate significant at the 0.1 per cent level.

At each sampling, sub-samples were taken and divided into sown grass, sown legume and unsown species. These were worked out as percentages and subjected to analysis. The results of the first cut were extremely interesting. On the *Trifolium semipilosum* plots the percentage of grass in the sward was low when no phosphate was applied but not nearly as low as the plots planted with *Trifolium repens*. On the phosphate plots the percentages were approximately the same. Whether this is due to a differential uptake of the phosphate by the clovers or to the indigenous clover being less exacting in its phosphate requirements requires more working out than the facilities at this station will allow but it is an interesting speculation. In general the phosphate increased the 1 per cent of sown species at the expense of weeds. This was apparent even in the third cut taken in December.

LEY ESTABLISHMENT TRIAL (1)

An experiment designed to evaluate the different methods of sowing a ley, viz. direct seeding, companion seeding and undersowing showed no significant difference between direct sowing, companion sowing with oats, lupins, oats and lupins and also sweet clover and undersowing to sunflowers but all were better than grass undersown to maize significant at the 0.1 per cent. This was based on the results of the first sample cut. By the second cut it seems likely that the differences will have evened out.

This will be repeated next year with the plots being grazed individually because unless this is done the results are biased in favour of the undersown.

LEY ESTABLISHMENT TRIAL (2)

An observation trial on the effectiveness of rolling the seed bed and consolidation by treading with stock showed that this is an extremely useful insurance measure. Both of the consolidated plots were quicker to establish than the control and although the effect was somewhat short-lived it appeared well worth doing. in fact if a dry period ensues after planting the grass can still get away.

Maize Spacing and Undersowing Trial

Because of the attractiveness of undersowing as a means of establishing a ley, an experiment was laid down to test the effect of undersowing at three different times using three maize spacings. The maize spacings were 2 ft. × 1 ft., 3 ft. × 1 ft. and 6 ft. × two rows 18 in. apart. The grass used was Nzoia Rhodes Grass.

The times of undersowing were intended to be with the maize, a month and six weeks after the maize planting. Owing to the weather dates could not be used accurately and in fact the grass was sown at the same time as the maize, 43 days and 79 days after the maize was sown. The sample cuts were taken after the maize was harvested. The results are shown in Tables IV and V.

Table IV—Maize Yields/Acre in Bags (200 lbs.)

Treatment	Yield	S.E.
Undersowing—		
Control (no undersowing)	14·13	
Undersown at planting	7·82	
Undersown 43 days after planting ..	11·52	S.E. ± 0·71.
Undersown 79 days after planting ..	14·23	
Spacing—		
2′ × 1′	12·23	
3′ × 1′	13·15	
6′ × 2′ rows 18″ apart	10·39	S.E. ± 0·50.

It appears therefore that in this area which is wet throughout the growing season in a normal year, there is little effect from undersowing a ley two months after planting the maize (in this experiment the maize was about 3 ft. high at the last undersowing time) so long as the maize population is reduced to about 15,000 plants per acre, for maize alone in this area the optimum population is a planted population in the region of 20,000 plants per acre.

The general level of maize yields was low because of the late planting (27th April, 1958).

Table V—Grass Yields in Tons Fresh Matter/Acre

Treatment	Yield	
Undersown—		
Control (not undersown)	2·88	
Undersown with maize	7·13	
Undersowing 43 days after planting ..	2·16	S.E. ± 0·51.
Undersowing 79 days after planting ..	0·83	
Spacing of Maize—		
2′ × 1′	2·33	
3′ × 1′	3·42	S.E. ± 0·32.
6′ × 2′ rows 18″ apart	4·00	

By the second sample cut it looks as though most of the effects will have been lost. Therefore for the best results the maize should be at a spacing of 3 ft. × 1 ft. or approximately 15,000 plants per acre and the undersowing done when the maize has reached 3 ft. in height.

It must be pointed out that the plots which were undersown early, apart from lowering the yield of maize considerably, produced a large bulk of very coarse grass.

Fertilizer Top Dressing Trial on a Nandi Setaria (*Setaria sphacelata*) Ley

A Setaria ley was top dressed with sulphate of Ammonia at 0, 1½ and 3 cwt. per acre and Superphosphate at 0, 1 and 2 cwt. at the begining of the long rains on 24th April.

The nitrogen effect was largely over by the first cut even at the high rate but the phosphate effect was evident throughout the season. Results up to 31st December, 1958, are given in Table VI.

Table VI—Yields of Fresh Matter in Tons/Acre (Total of 5 cuts)

Treatments	Nil	N1½ S.E. diff. 2 means = 2·88	N3	Means
P0	16·21	19·34	18·10	17·88
P1	17·23	24·36	21·55	21·05
P2	25·06	30·79	27·82	27·89
Means	19·50	24·83	22·49	

S.E. diff. means = 1.66.

For comparison the yields of the first cut are given in Table VII.

Table VII—Yields of Fresh Matter in Tons/Acre

Treatments	Nil	N1½ S.E. diff. 2 means = 0·90	N3	Means
P0	2·88	4·66	4·70	4·08
P1	3·36	6·64	7·66	5·89
P2	5·11	7·50	9·44	7·35
Means	3·78	6·27	7·27	

S.E. diff. means = 0.52.

The difference in the production due to Sulphate of Ammonia can at once be seen when compared with the total results of five successive cuts. This means that for continued heavy production from a ley much more fertilizer than is used at present must be employed.

Groundnut Variety Trial, Homa Bay

An experiment to test two varieties of groundnuts, Asiriye Mwitunde and S720, at spacings of 2 ft. × 2 ft., 2 ft. × 1 ft. and 1 ft. × 1 ft. using two cultivation methods, namely ridge planting versus flat, was carried out at Homa Bay. The results are given in Table VIII.

Table VIII—Yields in lbs. Shelled Nut/Acre

Treatment	Yield	S.E.
Varieties—		
Asiriye Mwitunde	703·7	S.E. diff. 2 means = 90·5
S720	571·0	
Spacings—		
2′ × 2′	154·8	S.E. diff. 2 means = 113·44
2′ × 1′	335·7	
1′ × 1′	609·0	
Cultivation—		
Ridge	540·9	S.E. diff. 2 means = 90·5
Flat	733·1	

Only in the spacings were the results significant where 1 ft. × 1 ft. spacing out-yielded that of 2 ft. × 2 ft. significant at the 1 per cent level. The 1 ft. × 1 ft. spacing out-yielded the 2 ft. × 1 ft. spacing significant at the 5 per cent level. The difference was mainly due to the incidence of "Rosette disease".

Neither the varieties (L.S.D. 5 per cent level 196.0) nor the cultivation (L.S.D. 5 per cent level 196.0) gave significant results.

Maize Spacings/Manurial Trial, Sotik

A 3^3 factorial experiment to test spacings of 3 ft. × 6 in., 3 ft. × 1 ft. and 3 ft. × 2 ft. (populations of 7,260, 14,520 and 29,040 prants/acre) and Sulphate of Ammonia and Superphosphate each at 0, 2 and 4 cwt. per acre was carried out at Sotik. The results are given in Table IX.

Table IX—Yields of Maize in Bags (200 lbs.)/Acre

Treatment	Yield	S.E.
(1) Spacing—		
3′ × 6″	21·66	
3′ × 1′	26·04	
3′ × 2′	22·13	S.E. diff. 2 totals = 1·51.
(2) Superphosphate—		
0 cwt.	18·21	
2 cwt.	24·49	
4 cwt.	27·12	
(3) Sulphate of Ammonia—		
0 cwt.	23·36	
2 cwt.	21·96	
4 cwt.	24·50	

The plots containing higher plant populations were damaged by two heavy storms and a certain amout of difference was lost. It is interesting to note that the phosphate response was economical at up to 3 cwt. of Superphosphate/acre.

Heavy rain immediately after application of Sulphate of Ammonia may account for the apparently poor response to Sulphate of Ammonia.

Passion Fruit Observations

Daily counts of aphids caught in traps have been taken with the view of finding their distribution throughout the year in connexion with the woodiness disease of passion fruit. From preliminary observation it appears that aphids only feed on the vines during the drier weather.

Potatoes

Observation plots of three blight resistant varieties of potatoes were laid down at Sotik. Dutch Van Robijyn was used as the control. Fertilizer was applied at the rate of 5 cwt. of Superphosphate per acre and 4 cwt. of Sulphate of Ammonia per acre, no F.Y.M. was available. The results are given in Table X.

Table X—Yields of Potatoes in Tons/Acre

Variety	Yield
Van Robijyn	8·15
E. 52	9·01
K. 52	7·59
C. 53	10·41

Blight (*Phytophthora infestans*) was found on all varieties but only on the Van Robijyn was it severe.

Wheat Variety Trial

The following are the yields of 13 wheat varieties which were put into a trial at Sotik:—

Table XI—Yields of Wheat in Bags/Acre

Kenya Supremo Yaqui ..	2.13	
Frontana Kenya Newthatch ..	4.83	
Mida M. Exchange	3.21	
Veranopolis	6.27	
Kentana 51	2.67	S.E. diff. 2 totals = 1.82 bags.
H.462	4.29	
Maria E.E. Timstein	3.14	
Kentana Yaqui Rock 22 ..	2.15	
Mentana Kenya C9906 ..	4.65	
Knapmans	1.70	
Rio Negro	5.95	
Barclays Menengai	1.37	
Kentana Yaqui 2587	2.74	

In addition, work was also carried out for the Senior Plant Breeder in the form of a wheat variety observation trial and also barley and oats variety trials.

ADDENDA

Observation trials on grass work were carried out at Homa Bay, Senetwet, Kabosson and Bomet.

At Homa Bay it was shown that for the establishment of a ley some form of consolidation is necessary. The grass used was Rongai Rhodes and the results were most spectacular.

A grid undersown to maize was successfully established at Kabosson (rainfall 35 in.) but the legumes soon died out. The legumes used were Kenya White, Ruepells and Subterranean Clover (Dwalganup) and *Medicago denticulata.* The grasses were *Panicum maximum* var. *trichglume,* Nzoia Rhodes, Rongai Rhodes and Molasses grass (*melinis minutiflora*).

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ANNUAL REPORT OF THE AGRICULTURAL OFFICER (EXPERIMENTS), CENTRAL PROVINCE, 1958

RAINFALL

1958	EMBU		MULINDUKO		KANJA	
	Inches	Days	Inches	Days	Inches	Days
January	0·58	5	0·58	2	0·71	7
February	2·34	4	0·54	3	1·44	10
March	2·12	8	1·49	5	2·35	10
April	11·03	19	8·36	11	5·69	18
May	19·17	22	18·14	17	14·12	25
June	1·94	20	1·43	11	1·72	20
July	3·55	21	1·93	11	2·82	21
August	0·22	6	0·01	1	1·13	11
September ..	0·38	6	0·05	1	0·25	4
October	2·91	12	0·81	4	3·00	10
November ..	7·70	11	7·65	13	12·68	12
December	3·17	12	3·71	12	3·63	17
TOTAL ..	55·11	146	44·70	91	49·54	165
1957	58·69	167	39·20	109	48·17	196

At Embu and Mulinduko, rainfall was well above average for the year. Yields of grass and crops were good. At Embu, the long rains continued rather late. Weed growth was strong and potato blight widespread. At Kanja, the Gathano mist season was poor.

Report on Experimental Work

HIGH BRACKEN ZONE, KANJA SUB-STATION 5,800 FT. A.S.L.

On chemical analyses, the soil on this station is characterized by low pH values (4.69) toxic levels of aluminium, very low levels of phosphate and calcium and low levels of exchangeable potassium and magnesium with a possibility of inducing magnesium deficiency by over liming. Similar characteristics are found throughout the high bracken soils of Central Province.

Fertilizer and Farmyard Manure Trials on Arable Crops

This trial is one replicate of a 2^5 factorial plot size 1/40 acre. Previous results appeared in the Annual Reports of 1956 and 1957. The treatments were sulphate of ammonia at 3 cwts. per acre versus nil, double superphosphate at 1½ cwts. per acre versus nil, muriate of potash at 2 cwts. per acre versus nil, magnesium sulphate at 2 and 1/7 cwts. per acre versus nil, farmyard manure at 15 tons per acre versus nil. All these treatments were initially applied in March, 1956. There was no reapplication in the long rains, 1957. All treatments were reapplied in the Gathano (July), 1957. With the exception of magnesium sulphate which was reapplied at 2 cwts. per acre, all rates were as above. The crop was "Muratha"-type maize, harvested in January, 1958.

TABLE 1—RESULTS—YIELDS IN 200 LB. BAGS DRY MAIZE GRAIN PER ACRE

	No D/Supers	D/Supers	Mean
No FYM	10·08	14·72	12·40
With FYM	18·54	20·42	19·48
Mean	14·31	17·57	15·94

Yield of Nil Plot = 9·36 bags/acre. C. of V. = 10·52%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Bags 200 lb. per acre	1·28	1·79	2·51

The response to FYM reapplied at 15 tons per acre was 7.08 bags and the response to reapplied double superphosphate at 1½ cwts. per acre was 3.26 bags, both significant at P0.001. The interaction of these factors was negatively significant at P0.05. The interaction between magnesium sulphate and double superphosphate was positively significant at P0.05, but as the main effect of magnesium was not significant, this effect is regarded with reserve. In the long rains 1956 on English potatoes the phosphate-FYM interaction was negatively significant at P0.01 and the phsophate-magnesium interaction positively significant at P0.01 where the main effect of magnesium sulphate did not reach significant. The main effects of FYM and double superphosphate were also significant at P0.001. Thus these two seasons results are a close parallel.

TABLE 2—RESULTS—YIELDS OF MAIZE STOVER IN LBS. PER ACRE

	No D/Supers	D/Supers	Mean
No FYM	3,975	5,380	4,677
With FYM	6,935	8,135	7,535
Mean	5,455	6,758	6,106

Yield of Nil Plot = 3,520 lb./acre. C. of V. = 10·9%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Lb./Acre	508	708	993

The increase due to reapplied FYM at 15 tons per acre was 2,858 lbs. stover per acre and to re-applied double superphosphate at 1½ cwts. per acre was 1,303 lbs. stover per acre. Both the effects were significant at P0.001. There were no significant interactions.

The experiment was sown to thousand-headed Kale in the long rains, 1958, but the crop was a total failure.

Lime Phosphate and Farmyard Manure Trial

This trial began in 1956 when all treatments were applied, and consists of two replicates of a 3 × 3 × 3 Factorial, plot size 1/40th acre. The treatments were:—

P0 P1 P2=Double superphosphate at Nil, 1 cwt. and 2 cwts./acre.

L0 L1 L2=Agricultural Lime at Nil, 3 tons and 6 tons/acre.

M0 M1 M2=Farmyard Manure at Nil, 10 tons and 5 tons/acre.

The 5 tons FYM was initially 2 cwts. per acre sulphate of ammonia for the 1956 year only. The results below show the residual effect of treatments applied to long rains, 1957, English potatoes.

Muratha-type maize was hand-planted 3 ft. × 1 ft. in the Gathano (July), 1957, and harvested in January, 1958.

Table 3—Results in 200 Bags Maize Grain per Acre

L0 = 11·79	P0 = 11·47	M0 = 10·41	
L1 = 12·07	P1 = 12·15	M2 = 12·36	(5 tons)
L2 = 12·47	P2 = 12·73	M1 = 13·57	(10 tons)

Yield of Nil Plots = 9·15 bags. C. of V. = 15·7%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Bags 200 lb. grain/acre	1·30	1·75	2·32

FYM at 10 tons per acre outyielded Nil FYM by 3.16 bags per acre.

FYM at 5 tons per acre outyielded Nil FYM by 1.95 bags per acre.

No other differences or interactions were significant.

Table 4—Results—Yield of Maize Stover in lbs. per Acre

L0 = 7,520	P0 = 6,989	M0 = 6,704	
L1 = 8,304	P1 = 8,136	M2 = 8,122	(5 tons)
L2 = 8,042	P2 = 8,742	M1 = 9,040	(10 tons)

Yield of Nil Plots = 6,460 C. of V. = 14·5%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Lb. Maize Stover per acre	787	1,060	1,404

Significant responses were obtained to both levels of FYM and to both levels of double superphosphate.

Outstanding differences were:—

FYM at 10 tons per acre outyielded Nil FYM by 2,336 lbs. per acre.

FYM at 5 tons per acre outyielded Nil FYM by 1,418 lbs. per acre.

Double superphosphate at 2 cwts./acre outyielded Nil by 1,753 lbs. per acre. There were no significant interactions.

In the long rains, 1958, Kerr's Pink English potatoes were planted by hand in late March at 24 in × 18 in. on mechanically-made ridges. FYM and double superphosphate were reapplied to relevant plots at relevant rates over the ridges before splitting back. Despite several anti-blight sprayings, the whole experiment succumbed to the disease before lifting on 25th-26th June.

Table 5—Results in 180 lb. Bags Fresh Tubers per Acre

L0 = 34·96	P0 = 30·54	M0 = 29·85	
L1 = 36·12	P1 = 37·69	M2 = 35·89	(5 tons)
L2 = 38·12	P2 = 40·98	M1 = 43·47	(10 tons)

Yield of Nil Plots = 25·67 bags per acre. C. of V. = 11·5%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
180 lb. Bags Fresh Tubers per acre ..	4·93	6·63	8·78

Significant increases were produced by both levels of FYM and by both levels of double superphosphate. No significant interaction on "F" test. Outstanding differences were:—FYM at 10 tons per acre (reapplied) outyielded Nil FYM by 13.62 bags per acre; FYM at 5 tons per acre (reapplied) outyielded Nil FYM by 6.04 bags per acre; 10 tons outyielded 5 tons by 7.58 bags per acre. Double superphosphate of 2 cwts. per acre outyielded Nil P. by 10.43 bags per acre; and P. at 1 cwt. per acre outyielded Nil P. by 7.15 bags per acre. P.2 outyielded P.1 by 3.28 bags per acre.

Fertilizer and Manurial Trial on Established Kikuyu Grass

This trial was laid down in April, 1956, as two replicates of a 2^5 Factorial, plot size 1/60th acre. Estimation of treatment effects was by a single Allen Autoscythe sample cut of 20 square yards per plot.

The plot treatments were:—

N=Sulphate of ammonia at 2 cwts. per acre versus nil.

P=Double superphosphate at 2 cwts. per acre versus nil.

K=Muriate of potash at 1 cwt. per acre versus nil.

L=Agricultural lime at 6.6 tons per acre versus nil.

D=Farmyard manure at 10 tons per acre versus nil.

All the above treatments were applied in April, 1956. In March, 1957 NPK treatments only were reapplied at the original rates. In March, 1958, the N and D treatments were reapplied as above. As the K treatment has never produced a significant result on this or any other trial at Kanja, it was replaced by Mulch. It had been noticed in field practice and confirmed in observation plots that if Kikuyu grass permanent pasture on this station was mulched, the growth habit of the stems of the grass was changed from horizontal to vertical with greatly increased leaf production. This is attributed to a change in the microclimate at ground level due to the mulch, and in particular to its shading effect. The mulch used was Napier grass (*Pennisetum purpureum*) carried on freshly cut and applied to give approximately a 50 per cent ground cover. The actual green weight applied was very high and attention must be devoted to reducing this to an economic level.

TABLE 6—RESULTS—TONS FRESH GREENSTUFF PER ACRE

Cut on the 10th June, 1958

	N	D/Supers	Mulch	Lime	FYM
With	9·27	8·08	8·53	7·29	8·59
Without	5·34	6·52	6·08	7·32	6·01
Difference	3·93	1·56	2·45	0·03	2·58

Yield of Nil Plots = 0·80 tons C. of V. = 19·4%

General Mean = 7·30 tons.

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Tons Greenstuff per acre	0·72	1·03	1·26

The responses to N, P, D and mulch were each statistically significant at P0.001. There were no significant interactions.

After this cut, the entire experiment was heavily grazed by cattle and sheep. There was no reapplication of any treatment. A sample cut was taken on 25th November, 1958, with the following results:—

TABLE 7—RESULTS—TONS FRESH GREENSTUFF PER ACRE

	N	D/Supers	Mulch	Lime	FYM
With	10·29	9·03	8·38	8·46	9·93
Without	6·82	8·08	8·72	8·65	7·18
Difference	3·47	0·95	0·34	0·19	2·75

Yield of Nil Plots = 3·89 tons.
General Mean = 8·55 tons. C. of V. = 24·92%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Tons Greenstuff per acre	1·08	1·44	1·89

The responses to FYM and sulphate of ammonia are each significant at P0.001. There were no significant interactions.

The mulch applied to K plots has virtually disappeared leaving no shade effect. A P0.05 response to agricultural lime appeared in May, 1957, one year after its application. In July, 1957, this response attained P0.01 significance. It has not reappeared over three subsequent sample cuts. It would appear to be uneconomic to apply lime to established Kikuyu grass at Kanja.

Star and Kikuyu Grass Zone, Embu Farm

A short term rotational trial was laid down in April, 1957. Its object was to test the best succession of three principal long rains crops grown at Embu and their relative responses to fertilizer and farmyard manure application following the grass break of the rotation. The effect of preceeding crops and residual effects of fertilizer and manurial treatments were assessed by a test crop of maize overall in the succeeding long rains. The grass was Rongai Rhodes (*Chloris gayana*) undersown to maize in the long rains, 1954. It was a vigorous and highly-productive ley on a fertile field which was ploughed out by a single-furrow deep-digger in the hot, dry season of February, 1957. A complete kill of grass was achieved.

The design was a 3^1 Factorial laid out as three replicates of a 3^3 Factorial. Plot size 1/40th acre. Fertilizer and manurial treatments on each of the crops, English potatoes, maize, and sweet potatoes were:—

N=Sulphate of ammonia at nil, 1 cwt. per acre, 2 cwts. per acre.
P=Double superphosphate at nil, 1 cwt. per acre, 2 cwts. per acre.
M=Farmyard manure at nil, 4 tons per acre, 12 tons per acre.

All treatments were applied to the seedbed except N to maize and sweet potatoes where half of each was applied to the seedbed and half top dressed in June.

TABLE 8—RESULTS, 1957—ENGLISH POTATOES VARIETY DUTCH ROBIJYN

Yields in 180 *lb. Bags of Fresh Tubers per acre*

N0 = 87·92	P0 = 94·91	M0 = 94·84
N1 = 97·04	P1 = 95·80	M1 = 97·06
N2 = 101·57	P2 = 95·82	M2 = 94·63

Mean Yield of the Experiment = 95·51 bags. C. of V. = 12·42%
Yield of Nil Plot = 87·11 bags.

Significant Differences	p = 0·05	p = 0·01
Bags 180 lb. per acre	13·69	20·73

There were no significant differences due to treatment though the effect of sulphate of ammonia at 2 cwts. per acre closely approached significance. The mean yield of the experiment is regarded as high.

Maize Variety Muratha

TABLE 9—YIELD OF DRY MAIZE GRAIN IN 200 LB. BAGS PER ACRE

N0 = 23·68	P0 = 24·45	M0 = 24·20
N1 = 24·15	P1 = 24·02	M1 = 23·76
N2 = 25·84	P2 = 25·19	M2 = 25·71

Mean yield of the experiment = 24·56 bags. C. of V. = 10·00%
Yield of nil plot = 25·30.

	p = 0·05	p = 0·01
Significant Differences		
Bags of 200 lb. Maize Grain	2·83	4·30

There were no significant differences due to treatments though the difference between 2 cwts. per acre sulphate of ammonia and nil sulphate of ammonia approached significance.

TABLE 10—MAIZE STOVER—YIELD IN TONS DRY MATERIAL PER ACRE

N0 = 4·96	P0 = 4·94	M0 = 4·48
N1 = 4·36	P1 = 4·84	M1 = 5·12
N2 = 5·76	P2 = 5·29	M2 = 5·48

Mean Yield of the Experiment = 5·02 tons. C. of V. = 19·43%
Yield of Nil Plot = 4·85 tons.

	p = 0·05	p = 0·01
Significant Differences		
Tons Dry Stover..	1·13	1·71

There were no significant differences on "F" test. On "T" test only, 2 cwts. per acre sulphate of ammonia outyielded 1 cwt. per acre sulphate of ammonia. (Significant at P = 0.05.)

Both maize and English potatoes were followed by a short rains crops of dwarf beans with no reapplication of treatments. The mean yield of the experiment was 802 lbs. per acre. There were no significant differences due to treatments. Sweet potatoes remained in the ground for ten months until harvest in February, 1958. Roots were 30.51 per cent of total plant material. The yields of the sweet potatoes, variety Gikanda, are given in Table 11.

TABLE 11—YIELD OF TOTAL FRESH PLANT MATERIAL IN TONS PER ACRE

N0 = 35·18	P0 = 34·62	M0 = 38·77
N1 = 34·67	P1 = 35·59	M1 = 34·14
N2 = 35·66	P2 = 35·30	M2 = 32·60

Mean Yield of the Experiment = 35·17 tons. C. of V. = 18·32%
Yield of Nil Plot = 35·30 tons.

	p = 0·05	p = 0·01
Significant Differences		
Tons Total Fresh Plant Material per acre	7·43	11·26

There were no significant differences due to treatment.

On chemical analysis, this soil is low in available phosphate. Significant and economic responses are obtained to the application of double superphosphate. Responses to farmyard manure are normally expected and generally obtained. Responses to sulphate of ammonia are obtained towards the end of the arable break when the land has carried three or four long rains crops.

Bearing in mind that this field is a fertile one and the rainfall very favourable with consequent high yields, this total lack of any validly significant response to treatment is thought to be due to the effect of the ley. Under the farmyard manure treatment this vigorous ley produced a dense mass of roots which, on plough-in, made available for decomposition a considerable quantity of organic matter. On breakdown, this steadily released large quantities of plant food available to the crops, thus masking the effects of even 12 tons FYM per acre. Similarly, under the phosphate treatment, the deep rooting grass brought up phosphate from lower soil layers and concentrated it near the surface. On root decomposition after ploughing, the phosphate became available to the crops, thus masking the effect of treatment phosphate. This field received 1 cwt. per acre double superphosphate in the long rains, 1954. It is not thought that any residual effect would be of any importance in masking treatment phosphate.

With regard to the nitrogen treatment, the E.A.A.F.R.O. Annual Report, 1957, cites work on the flush of nitrate nitrogen obtained on rewetting of air-dry forest soil. This is stated to be of the order of the equivalent of almost half a ton of sulphate of ammonia per acre. It would appear that the magnitude of this flush is related to the amount of organic matter in the soil. If a similar result were found on Kikuyu red loam at Embu following the January-February hot, dry season, to apply sulphate of ammonia to the seedbed at the beginning of the rains would produce no response in the crop.

The same experiment was laid down in the long rains, 1956, on adjacent field wth identical treatments and crops. The results were strikingly similar to the long rains, 1957, results. There was a total lack of response to the phosphate and nitrogen treatments. Farmyard manure at 12 tons per acre produced a significant response in maize stover (P0.01) and to both 4 tons per acre and to 12 tons per acre on sweet potatoes. The Rongai Rhodes grass ley on the 1956 field was far poorer and far less productive than the 1957 field. The root mass produced far less organic matter for ploughing, hence the response to Farmyard manure. The 1956 growing season was as favourable as that in 1957, yet average yields on all three crops were approximately half those of 1957 trial.

Another experiment at Embu has shown that on this farm, under a continuous arable regime, there is a steady decline in crop yields despite application of 6 tons FYM per annum or alternatively 18 tons every third year. If, under a system of alternate husbandry, soil structure and fertility can be indefinitely maintained or even improved in terms of the yields of subsequent arable crops there is a very considerable case for ley farming. It is thought that by its negative answer, that is what this experiment indicates.

In its second year, the short-term rotational trial became one replicate of a 3^4 Factorial with a test crop of maize overall, the sulphate of ammonia treatment was replaced by double superphosphate reapplied to the seedbed at nil, 1 cwt. and 2 cwts. per acre. The "P" and "M" treatments remained to test residual effects.

"Muratha"-type maize was hand-planted at 3 ft. × 1 ft. on 9th April and harvested on 8th October, 1958.

TABLE 12--RESULTS—200 LBS. BAGS OF MAIZE GRAIN PER ACRE

N0 = 19·18	P0 = 19·62	M0 = 19·97
N1 = 20·09	P1 = 20·18	M1 = 19·93
N2 = 20·93	P2 = 20·41	M2 = 20·31

Maize preceded by Maize	18·30
Maize preceded by English Potatoes ..	20·57
Maize preceded by Sweet Potatoes ..	21·33

Mean Yield of the Experiment = 20·07 bags. C. of V. = 10·43%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
200 lb. Bags Maize Grain per acre ..	1·15	1·54	2·02

TABLE 13—YIELDS OF DRY STOVER IN POUNDS PER ACRE

N0 = 4,135	P0 = 4,471	M0 = 4,536
N1 = 4,462	P1 = 4,372	M1 = 4,413
N2 = 4,873	P2 = 4,627	M2 = 4,520

Maize preceded by Maize	3,884
Maize preceded by English Potatoes ..	4,569
Maize preceded by Sweet Potatoes ..	5,017

Mean of the Experiment = 4,490 lb. C. of V. = 22·51%

Significant Differences	p = 0·05	p = 0·01	p = 0·001
Tons Dry Stover per acre	556	744	976

Reapplied double superphosphate at 2 cwts. per acre outyielded nil phosphate by 1.75 bags of grain per acre, P0.01. The response was linear. There were no significant differences due to any level of either residual double superphosphate or farmyard manure. In terms of both maize grain and maize stover, maize following maize is markedly inferior to maize following sweet potatoes. This is a cogent argument against successive maize crops. This effect was also demonstrated in the previous edition of this trial to which reference has been made. Maize following sweet potatoes has a slight but not significant advantage on maize following English potatoes of 0.76 bags grain and 447 lb. stover per acre.

The effect of sweet potatoes is attributed to better soil structure under the continuous ground cover, shading and the surface rooting of sweet potatoes. Shade and ground cover is a transient effect with English potatoes, but is considered to have the same effect. Considerably more soil movement is involved in the growing of maize and English potatoes and their short rains beans crop than in growing sweet potatoes where the ground is undisturbed for some nine months.

Conclusions to be drawn with regard to a rotation are that successive maize crops are not a good thing. Owing to the high cost of breaking a ley, a cash crop should be grown. As the mechanical cultivation of English potatoes entails a considerable amount of physical shattering of clods, this crop should be grown when the land is best able to stand it. Thus on two counts it should be grown as the first crop in the arable shift.

Sweet potatoes are in the ground undisturbed for a considerable time. The soil is not subject to physical shattering in the same way as for English potatoes. Due to the total ground cover produced and surface rooting characteristics, this crop should be grown towards the end of the arable break to preserve or even improve soil structure. The long rains cropping at Embu has now been changed to: English potatoes, maize, sweet potatoes, maize undersown to grass.

Despite the negative response to fertilizer and FYM, in practice one would hesitate to withhold phosphate and FYM from English potatoes. Fertilizer and manure would be applied to the root crops. Both the maize crops would then grow on fertilizer and manurial residues, if any.

Coffee Variety Trial, Embu Farm

This trial was planted in 1950 to test five varieties of Arabica coffee in a 5 × 5 Latin square with nine tree plots at 9 ft. × 9 ft. spacing on mulched box ridges. The trial is now in its second cycle. There were no significant differences on F test in the 1958 results.

TABLE 14

	Lb. Cherry per Plot Mean	Cwt. Parchment per Acre 6:1 cherry/clean coffee ratio	
SL.34	153·5	13·63	
SL.28	153·0	13·60	
SL.14	145·1	12·90	
N 197	124·3	11·05	
Kents	108·5	9·64	
		12·16	Mean
Least Significant Differences	p = 0·05	p = 0·01	
Cwt. Parchment Coffee per acre ..	3·27	4·75	

The order of the varieties in term of yield is in accordance with previous results.

DISTRICT FERTILIZER TRIALS

These are subject to report by the Senior Soil Chemist, Scott Agricultural Laboratories, Nairobi. They continued satisfactorily throughout the Province. There are now 41 2^4 Factorial exploratories and 10 3 × 3 × 3 Factorial rates trials. There is a slight increase for 1959. Broadly, the beneficial effects of FYM and double superphosphate on maize and English potatoes continues to be demonstrated. Responses to sulphate of ammonia have been obtained on land that has been under cultivation for a considerable number of years.

Grass Woodland Zone, Mulinduko Farm, 4,200 feet

A trial was laid down in April, 1955, to gain further information on response to levels of FYM and double superphosphate and their interactions. The design was two replicates of a 3 × 3 × 3 Factorial, plot size 1/50th acre with the following treatments:—

M = FYM at nil, 2½ tons per acre row placed and 10 tons per acre broadcast.

P = Double superphosphate at nil, ½ cwt. per acre, 1 cwt. per acre.

X = Repetitive treatment not yet applied.

These treatments were applied in the long rains, 1955. Due to lack of response at these levels, the rates were increased to: FYM at nil, 3 tons per acre and 12 tons per acre and phosphate at nil, 1 cwt. per acre and 2 cwts. per acre in the long rains, 1956. In the long rains, 1957, the M and P treatments were left for residual and the repetitive treatments applied. These were:—

Double superphosphate at 1 cwt. per acre (X_0), FYM at 3 tons per acre (X_1) and FYM at 12 tons per acre (X_2).

In the long rains, 1958, the repetitive treatments were left for residual, the M and P treatments reapplied at the 1956 rates.

Cropping since the trials inception has been: 1955, long rains maize, short rains millet, L.R. 1956 maize, S.R. beans, L.R. 1957 Groundnuts, S.R. sorghum, L.R. 1958 English potatoes. Significant responses were obtained in the S.R. 1955 (M2, P1, P2) S.R. 1956 (M1, M2, P1). L.R. 1957, (M2 and X2). No significant interactions have been obtained. The results for 1958 are given in Table 15.

TABLE 15—YIELDS OF ENGLISH POTATOES (VARIETY KERR'S PINK) IN BAGS/ACRE

M0 = 37·13	P0 = 42·05	X0 = 42·78
M1 = 47·11	P1 = 47·76	X1 = 45·02
M2 = 57·52	P2 = 51·94	X2 = 53·97

Yield of Nil Plot = 37·64 bags/Acre. C. of V. = 20%

Mean Yield of the Experiment = 47·25 bags/acre.

Significant Differences	p = 0·05	p = 0·01	p = 0·001
180 lb. Bags Fresh Tubers per acre ..	6·42	8·64	11·47

Reapplied double superphosphate at 2 cwts. per acre outyielded no phosphate by 9.89 bags per acre. (Significant at P=0.01.) There was no significant difference between P1 and P0 or between P2 and P1 (2 cwts. per acre and 1 cwt. per acre).

Reapplied FYM at 12 tons per acre outyielded no FYM by 20.39 bags per acre,and reapplied FYM at 3 tons per acre by 10.41 bags per acre. Reapplied FYM at 3 tons per acre outyielded no F.Y.M. by 9.98 bags per acre.

The repetitive treatment X2, residual FYM at 12 tons per acre outyielded both X0, 1 cwt. double superphosphate per acre by 11.19 bags P0.01 and X1, residual FYM at 3 tons per acre by 8.95 bags. There was no significant difference between residual FYM at 3 tons per acre and reapplied, double superphosphate at 1 cwt. per acre.

There were no significant interactions.

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ANNUAL REPORT OF THE COTTON RESEARCH OFFICER NYANZA PROVINCE, 1958

Cotton Experiment Station, Kibos

Plant Growth Analysis

A full write-up of this work will be given in the Empire Cotton Growing Corporation's Progress Report, Kenya, 1958/59 Season.

Seed Dressing Trials

Results from the use of copper and mercurial seed dressings show that the former do not give adequate protection against primary infection from bacterial blight (*Xanthemonas malvacearum*) and that the latter are very promising.

Mulching and Sulphate of Ammonia Applications to Partially Waterlogged Land

Three sets of experiments were laid out on land on which water lies for a period after rain and where plant growth is poor. The experiments were identical except that one trial was planted on fat land and two on land which had been cultivated into tied bench ridges. Treatments were Control (no treatment), application of 1 cwt. sulphate of ammonia per acre, application of plant debris mulch after emergence of plants, application of a plant debris mulch and 1 cwt. sulphate of ammonia per acre, application of rice husk mulch after emergence of plants, application of a rice husk mulch and 1 cwt. sulphate of ammonia per acre. The results are given in Table I:—

Table I—Yields in lb. of Seed Cotton per Acre

Treatment	Flat Cultivation	Tied Bench Ridges	Tied Bench Ridges
Nil	400·7	507·9	489·3
1 cwt. S. of A	381·5	600·8	561·8
Plant debris mulch	369·6	613·8	516·1
Plant debris mulch and S.A. ..	200·5	346·7	315·7
Rice husk mulch	154·8	886·7	817·4
Rice husk mulch and S.A. ..	338·7	677·1	610·9
S.E.	96·4	93·8	84·1
L.S.D. (p = 0·05)	N.S.	293·6	265·1

The mulch from plant debris soon disappeared due to rotting and termite activity and was not renewed. The rice husk mulch persisted throughout the season and did not appear to be affected by any of the agencies which removed the trash.

In the trial planted on the flat there were no significant differences between treatments and none were as good as control. In the other two trials the rice husk mulch yields were significantly higher than control, trash plus sulphate of ammonia and in one case the application of plant trash.

Application of nitrogen under these wet conditions seems to have had a varied effect. On the flat it depressed yields where applied to bare land and that with plant trash and increased yields on the plots under rice husk. On tied bench ridges which were wetter than the flat land due to conservation of rainfall, the effect of sulphate of ammonia was to increase the yield on bare land and depress yields under mulches.

Breeding

Seed of DE715/6 m from Serere, Uganda, was used at Kibos this season for selection purposes. It was intended to obtain from this variety a bulk which would be more suited to Nyanza conditions, retaining the spinning qualities of the Uganda material.

It is likely that the decision to grow this variety on both sides of the Kenya/Uganda border will be deferred until trials in Uganda with the new N.C. type have been completed. If the Uganda Government decide to use N.C. to replace the present variety, S47, the same variety will have to be grown on the Kenya side of the border and new breeding programmes with N.C. will have to be started.

Cotton Sub-station, Busia

Variety Trials

Duplicate variety trials were planted with the object of having one sprayed against lygus and the other unprotected. Unfortunately the spray material was too late in arriving and both trials were unprotected. The varieties used were S.47, DE715/6 m, UK51 and UK55. The possibility of N.C. being introduced into this area was not known at the time of planting and consequently was omitted from the trials. The results are shown in Table II:—

Table II—Yield in lbs. of Seed Cotton/Acre

Variety	Trial I	Trial II
S.47	203·9	144·7
DE 715/6m	223·6	157·8
UK 51	269·6	223·6
UK 55	289·3	203·9
S.E.	33·4	21·5
L.S.D.	N.S.	N.S.

In neither of the trials were the differences significant. The later maturing varieties did better than the early types and this was probably due to well-distributed rains late in the season. In this period 23.39 inches of rain fell. Lygus and bacterial blight caused considerable damage. The incidence of stained cotton was very high.

Spacing Trials

Like the variety trials one set was to be protected and the other unsprayed, but both were unsprayed. The treatments were: rows 3 ft. apart, holes 2 ft. apart, 2 plants/hole; rows 3 ft. apart, holes 1½ ft. apart, 2 plant/hole; rows 3 ft. apart, holes 1 ft. apart, 2 plants/hole; rows 3 ft. apart, holes 1 ft. apart, 1 plant/hole; and rows 3 ft. apart, holes 9 in. apart, 1 plant/hole. The plots were 42 ft. × 18 ft. after guard rows had been removed. Cultivation was on tied bench ridges. In neither trial were the differences in yield significant.

TABLE III—YIELDS IN LBS. OF SEED COTTON PER ACRE

SPACING	Trial I	Trial II
3′ × 2 × 2 plants	182·5	153·7
3′ × 1½′ × 2	158·5	216·1
3′ × 1′ × 2	153·7	192·1
3′ × 1′ × 1	182·5	177·7
3′ × 9″ × 1	163·3	158·5
S.E.	10·4	27·5
L.S.D.	N.S.	N.S.

District Plots

DATES OF PLANTING TRIALS

Date of planting trials were sited at Amukura, Mundika in Elgon Nyanza, and at Funyula and Bukangala in Central Nyanza. The results of the two former trials have been received and are given below. There were four dates of planting, April, May, June and July. The layouts were 4 × 4 Latin squares.

TABLE IV—YIELDS IN LB. OF SEED COTTON/ACRE

DATE OF PLANTING	SITE	
	Amukura	Mundika
April	408·4	930·2
May	340·3	680·6
June	351·7	680·6
July	329·0	669·3
S.E.	19·6	84·3
L.S.D.	N.S.	N.S.

Between these plots there were considerable differences in fertility and the degree of damage due to lygus and bacterial blight. None of the treatments were significant.

G.P.K. 2937—725—10/59